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ART. I.—*Description of the Remains of a new Enaliosaurian (Eosaurus Acadianus), from the Coal Formation of Nova Scotia;* by O. C. MARSH, B.A., of the Sheffield Scientific School, Yale College.—With Plates.

[Communicated to the Geological Society of London, May, 1862.]

THE Reptilian remains from the Coal-measures, hitherto described, are few in number, and have nearly all been regarded as Batrachian, or Amphibian. Previous to the year 1844, the existence of even this low form of reptilian life during the Carboniferous period was unsuspected by most geologists, and its first appearance upon the earth confidently referred to the Permian epoch. In that year Hermann von Meyer announced the discovery in the Rhenish Bavarian Coal-measures of a reptile allied to the Salamanders, which he described under the name *Apateon pedestris*;* and about the same time Dr. King published an account of the footprints of a large Batrachian, which he had observed in the coal strata at Greensburg, Penn.† In 1852 Sir Charles Lyell and Prof. J. W. Dawson obtained in the Coal-measures of Nova Scotia the bones of the *Dendrerpeton Acadianum* (Wyman and Owen), which were the first reptilian osseous remains described from the Carboniferous rocks of America.‡

* Leonhard und Bronn, *Neues Jahrbuch für Mineralogie*, etc., 1844, page 336.

† Description of fossil footmarks (of *Thenaropus heterodactylum*) found in the Carboniferous series in Westmoreland County, Penn.; by Alfred T. King, M.D. Am. Journal of Science, vol. xlviii, page 343. Also in vol. i, new series, page 268.

‡ On the remains of a reptile (*Dendrerpeton Acadianum*, Wyman and Owen), and of a land shell discovered in the interior of an erect fossil tree in the Coal-measures of Nova Scotia; by Sir Charles Lyell, F.R.S., &c., and J. W. Dawson, Esq. Quarterly Journal of the Geological Society, London, May, 1853, vol. ix, p. 58.

Since these discoveries were made, the Coal-fields of England and Nova Scotia, as well as those of Ohio and Pennsylvania, have afforded additional Batrachian, or Amphibian, bones and footprints, so that at the present time the prevalence of this type of reptilian life during the Carboniferous period is generally admitted. The more recent researches of Prof. Dawson in the Coal formation of Nova Scotia have been rewarded by the important discovery of a new genus (*Hylonomus*) of very small reptiles, which, he considers, had affinities to the Lacertians, and possibly belonged to that family, rather than to the Batrachians.*

The remains which form the subject of the following description are of great interest, since they indicate the existence during the Palæozoic period of a group of highly organized marine reptiles of large size, which have previously been found only in Secondary strata. These remains consist of two vertebræ, or more strictly two centra or bodies of vertebræ; and their appearance, when separated from the matrix which contained them, is well represented in the first of the accompanying Plates, figures 1 and 2. The vertebræ were discovered by the writer in August, 1855, while examining the Coal-measures of Nova Scotia in company with his friend, Mr. William E. Park, of Andover, Mass. Their resemblance in form and appearance to the vertebræ of an *Ichthyosaurus* was so marked, that at the time of the discovery the writer referred them to that genus, and made a careful exploration in the vicinity for further remains, but without success. As soon as an opportunity occurred, the fossils were compared with the vertebræ of *Ichthyosauri* from the Lias, and, although some points of difference were noticed, the Enaliosaurian characters seemed to be equally well marked in each. Wishing to obtain, if possible, some additional remains, the writer for some time deferred publishing a description of the vertebræ; but a careful re-examination of the locality during the past summer afforded nothing of a similar nature, and there seemed to be no reason for longer delay in announcing so important a discovery. The remains were, accordingly, briefly noticed by the writer in the last number of the American Journal of Science; and, as they appeared to be generically distinct from any hitherto described, he then proposed for the species the name *Eosaurus Acadianus*, in allusion to the early appearance on the earth of this higher type of reptilian life.†

The locality which furnished these fossils is at the South Joggins Coal formation, in Nova Scotia, on the southern shore of

* Proceedings of the Geological Soc. of London, 1859. Also Supplement to Acadian Geology, page 32.

† From ἠώς, the dawn, and σαῦρος, a lizard. The specific appellation is from Acadia, a former name of Nova Scotia.

the Chiegnecto channel, a branch of the Bay of Fundy. The Coal-measures at this place, according to Sir W. E. Logan,* have a vertical thickness of 14,570 feet, or nearly three miles; and contain seventy-six distinct seams of coal, with erect trees and plants at twenty-two different levels. The strata dip to the south at an angle of about 25°; and the destructive tides of the bay are constantly undermining the high cliffs, and exposing for miles along the coast fresh sections, rich in fossil treasures of vegetable and animal life.

The present remains were imbedded in a stratum of argillaceous chocolate-colored shale, which forms part of group XXVI. in the elaborate section of this formation made in 1852 by Sir Charles Lyell and Prof. J. W. Dawson.† The position of this group is a little more than 10,000 feet above the lower limits of these Coal-measures, and beneath nearly 5,000 feet of coal strata, containing at least twenty separate veins of coal. It is about 800 feet above the locality which afforded the remains of the *Dendrerpeton* and *Hylonomus*.

This group is sixty-six feet in thickness; and consists of chocolate and gray shales, containing ironstone nodules, and interstratified with bands of gray sandstone, in which may occasionally be observed ripple marks, and carbonized land plants. Erect *Sigillariæ*, often of large size, occur at one level, and erect *Calamites* at another. Prof. Dawson considers these deposits estuary or fluviatile sediments, covering flats, which were at times dry, or nearly so, and at others inundated. On one of the rippled sandstones he noticed a series of footprints, which he supposes might have been made by a large *Dendrerpeton*.

Group XXV., immediately beneath the locality of the vertebræ, is about twenty feet in thickness; and consists of a series of underclays, or fossil soils, with *Stigmaria*, and small seams of coal, in which may be seen *Sigillariæ* and *Lepidodendra*. Two feet below group XXVI. there is a stratum of bituminous limestone, which contains the scales of ganoid fishes (*Palæoniscus*), coprolites, bivalve shells of the genus *Naiadites*, and *Spirorbis carbonarius* attached to plants and trunks of *Sigillariæ*.

The vertebræ, as already stated, are two in number; and when discovered were attached to each other, as shown in Plate I. figures 1 and 2. Their uniformity in size and appearance, as well as their collocation when found, would indicate that they belonged to the same animal, and were contiguous in the vertebral column. They are remarkably well preserved; and this results from their complete ossification in their natural state, as well as from the peculiar matrix which has since contained them, and furnished the material for their mineralization. The posterior

* First Report on the Geology of Canada, 1845.

† Transactions Geological Society of London, 1853.

vertebra, in fact, with the exception of a small fracture, seems to be nearly as perfect as in its original condition; and from it the description and measurements which follow are mainly taken.

A close examination of the fossils shows, that, subsequent to the death of the animal, and before being imbedded in the shale, they were subjected to considerable violence. One of them has been pushed aside from its original position about one-third of its diameter, and also turned on its axis about 90°, so as to leave its superior surface in apposition with the lateral surface of its fellow. Through the center of the anterior vertebra an irregular cavity has been made, and a wide fissure separates a segment from the rest of the centrum (Plate I. figure 2). The edges of each of the fossils are somewhat abraded, apparently from having been rolled about by water: this, however, could not have been long continued; as the delicate reticulated texture of the non-articular surfaces, being protected by their slight concavity, is perfectly preserved (Plate I. figure 1, and Plate II. figure 4). These injuries were evidently all received before the entombment of the vertebræ; and, as no similar remains could be found in the vicinity when these were discovered, it is quite probable that the same force, which caused the injuries, also widely separated the different parts of the skeleton.

The general form of the vertebræ is cylindrical, but their sides are somewhat compressed obliquely, which gives to the contour of the centra a subhexagonal appearance. They are much flattened in the direction of the antero-posterior diameter, which has to the transverse diameter about the proportion of 1 to 3. Both the articular terminal facets are deeply and equally concave; but from the center to the margin the surfaces are convex, and this convexity is greatest near the center, as represented in Plate II. figure 2. The cavities for the reception of the intervertebral matter begin immediately from the margin; and are considerably deeper than in the corresponding parts of the *Ichthyosaurus*, indicating a greater degree of flexibility in the spinal column. The margins of the vertebræ are somewhat raised, as if they had yielded to a forcible compression applied longitudinally; and hence the lateral surfaces of the centers are concave in an antero-posterior direction. This concavity is greater in the upper half of the vertebra, and was undoubtedly more marked originally than at present, since the appearance of the margins indicates considerable abrasion. The non-articular surfaces of the centra are smooth and regular; and the external fibres of the osseous tissue are singularly reticulated, as seen in Plate I. figure 1, and in the magnified view, Plate II. figure 4.

The neurapophyses are not anchylosed to the centrum, as in the Mammalia, nor connected to it by sutures, as in the Crocodiles; but their union with the vertebra is indicated by two pits,

which served for their articulating surfaces. These depressions are situated on the superior surfaces of the centrum, intermediate between the anterior and posterior margins of the extremities. They are circular in form, and sink directly into the body of the vertebra; instead of being elongated longitudinally, and raised on ridges, as in the *Ichthyosauri*. The pits are about a line in depth, and in the more perfect of the fossils are not in their original position; as a fracture in the upper part of the centrum has pushed them obliquely apart, so that a line passing through their centers would form an angle of about 30° with the transverse diameter of the vertebra. The depressions occupy about one-third of the distance between the margins of the articular extremities, indicating that the base of the neural arch was of less antero-posterior extent than the centrum. The floor of the spinal canal is narrow, being but five lines in breadth; and its surface in the posterior vertebra is broken by the fracture, previously mentioned, which passes lengthwise through its center. No neurapophyses were found with these fossils, but the nature of the superior arch is indicated by the articular surfaces which served for its attachment. Without doubt its ossification was complete, since the neurapophyses are never inferior in this respect to the body of the vertebra. It is also probable that in the present case these parts were anchylosed to each other and to their spine, as in the neural arch of the *Ichthyosaurus*.

A rudimentary transverse process, or exogenous tubercle, is sent off from each lateral surface of the centrum, at points equidistant from the extremities of the vertical diameter (Plate II. figures 1 and 2, *b* and *b'*). Their position is near the margin of the anterior articular surface, and the edges of these parapophyses make the transverse diameter of this extremity somewhat greater than that of the corresponding posterior facet. At the surface of the vertebra, each of these tubercles is about six lines in diameter; but they rapidly diminish in size as they extend outward, and at a distance of one and a half lines from the centrum terminate in obtuse points. They present no indications of articular surfaces; but externally appear to be composed of radiating fibres of osseous tissue, and without doubt served for the attachment of muscles. These elevations resemble in form and position the rudimentary transverse processes on the caudal vertebræ of the *Ichthyosaurus tenuirostris*, and this similarity affords some ground for referring these fossils to the same part of the vertebral column. That their true position is in the anterior or central caudal region, is further indicated by the absence from the centrum of true costal surfaces, or articular depressions for the attachment of ribs, which we should expect to find present in the cervical or dorsal part of the spinal column; and also by the

absence of a lateral compression of the centers, which, in the *Ichthyosauri*, marks the posterior caudal vertebræ. Both of the fossils are somewhat injured on their inferior surfaces, and hence it is impossible to ascertain from the specimens themselves whether hæmapophyses originally existed.

The following admeasurements were taken from the nearly perfect vertebra of the *Eosaurus*. For the purpose of comparison, the corresponding dimensions of an anterior caudal vertebra of an *Ichthyosaurus* are added. It will be seen that the most marked differences are in the position and dimensions of the pits for the articulation of the neural arch, and in the depth of the terminal concavities.

ADMEASUREMENTS OF VERTEBRÆ.

	Eosaurus.		*Ichthyosaurus.*	
	inches.	lines.	inches.	lines.
Transverse diameter of centrum on anterior surface,	2	4	2	6
Ditto on posterior surface,	2	3	2	5
Ditto including the parapophyses,	2	6	2	7
Vertical diameter on anterior surface,	2	2	2	3
Antero-posterior diameter on superior surface,		10	1	3
Ditto on inferior surface,		9	1	1
Ditto between centers of articular facets,		1		4
Length of pits for articulation of neural arch,		3		9
Breadth of ditto,		3		2
Depth of ditto,		1		1
Distance between centers of ditto,		5	1	1
Ditto and centers of parapophyses,	1	5		

The dimensions of the other vertebra of the *Eosaurus*, so far as they can be accurately ascertained, coincide almost exactly with those given above.

In the margin of one of the vertebræ there is an angular notch, about a line in depth, which deserves to be noticed on account of the importance attached to it by Prof. Agassiz, who first called the attention of the writer particularly to it. Its position is in the upper part of the posterior terminal facet of the centrum, behind and between the pits for the articulation of the superior arch. From the margin, where it is deepest, it extends for a short distance toward the center, and gradually becomes obliterated (Plates I. and II. figure 1, *c*). On the anterior surface of the same vertebra, at a point opposite and nearest to this depression, there is an elevation, which in position and dimensions apparently corresponds to it; and the two, when taken together, naturally suggest that they may be the result of some pressure applied to the anterior surface of the vertebra before it was in its present fossilized condition. Prof. Agassiz, after

a casual examination of the vertebræ, expressed the opinion that the notch and elevation were organic, rather than accidental; and as such were indicative of an inferiority of structure, which would place the genus of reptiles to which the remains belong somewhat lower than the *Ichthyosauri*. In a recent letter to Prof. Silliman, Jr., on the subject, he writes as follows:

"Mr. Marsh has shown me to-day two vertebræ from the Coal Formation of the Joggins, which have excited my interest in the highest degree. I have never seen in the body of a vertebra such characters combined, as are here exhibited. At first sight they might be mistaken for ordinary Ichthyosaurus vertebræ; but a closer examination soon shows a singular notch in the body of the vertebra itself such as I have never seen in Reptiles, though this character is common in Fishes. We have here undoubtedly a nearer approximation *to a synthesis between Fish and Reptile* than has yet been seen. * * * * The discovery of the Ichthyosauri was not more important than that of these vertebræ; * * * I do not believe that there is a vertebra known thus far, in which are combined features of so many vertebræ, in which these features appear separately as characteristic of their type."

At the time Prof. Agassiz saw these remains, they were only partially separated from the shale in which they had been imbedded, and consequently his examination could not be perfectly satisfactory. Since then, the matrix has been carefully removed, and an opportunity afforded for comparing the other similar parts of both vertebræ. This comparison, however, shows no corresponding notch or elevation at the opposite points of the same centrum; and none whatever on the other vertebra, where such should exist if these peculiarities were organic.

Prof. Jeffries Wyman, to whom the writer had previously submitted the vertebræ, and to whose kindness he is indebted for many valuable suggestions in regard to them, considers the notch purely accidental; and a result of the same fracture which has displaced the articular pits of the superior arch. It is also the opinion of this eminent anatomist that the notch would not be sufficiently important, if it were organic, to affect at all the Enaliosaurian character of the remains.

A microscopic examination of the osseous structure of these vertebræ of the *Eosaurus* exhibits well-marked Reptilian characters. The Haversian canals are few in number, but large in size, as is usual in this class. The lacunæ, although somewhat irregular in shape, are much elongated, and show very little resemblance to the quadrate or stellate form of the bone cells in fishes. They are frequently arranged concentrically around the Haversian canals, as represented in Plate II. figure 3, and their walls are almost invariably well defined. The canaliculi, as in the *Ichthyosaurus* and *Plesiosaurus*, are not numerous, but appear to be finer than those in most saurians. They do not taper off

and ramify, as in the bones of fishes, nor anastomose with the corresponding tubes from the neighboring cells, although in one of the longitudinal sections there are a few indications of such a connection. Some of the other sections examined show a larger number of canaliculi than those in Plate II.; but generally there are only a few of these tubes attached to each lacuna, and in some cases they appear to be entirely wanting. As the canaliculi vary much in number in different saurians, and also with the age of the animal, their paucity in this case is not remarkable. It is possible, however, that the method employed in preparing the sections was not well adapted to rendering these minute tubes visible. In a part of the transverse section shown in Plate II. figure 5, a structure is seen which is quite different from the surrounding osseous substance. This may be due to the presence of a small cavity in the bone before the introduction of the mineral matter, or to an imperfect ossification at that point: more probably the latter, as these vertebræ, like those of the *Plesiosaurus*, show in their interior structure a degree of ossification somewhat inferior to that at the articular terminal surfaces.

The vertebræ of the *Eosaurus*, in their biconcave centers, exhibit a structure which prevails in the class of Fishes; in the Labyrinthodonts, as well as in a few genera of extinct Saurians; and which is seen in existing reptiles only in the Geckos, and the perennibranchiate division of Batrachians. These vertebræ, however, present such marked characters in their very short antero-posterior diameter, in their deep and regular terminal concavities, and in the separate condition of their neurapophyses, that, in determining the position to which their anatomical features entitle them to be assigned, we may safely limit our comparison to the Fishes, and to those genera of extinct Saurians which possessed similar characters.

In comparing these remains with the former class, there is at once apparent a much closer resemblance in the above respects to the vertebræ of the *Plagiostomi*, than to those of any other order. The remains of these fishes have been found in all fossiliferous strata above the Lower Silurian, but no vertebræ except in the more recent rocks. In the Cretaceous and Tertiary formations one family of this order, the *Squalidæ*, have left numerous and well preserved vertebræ; and the writer has carefully compared the remains of the *Eosaurus* with a large number of these and other similar fossils, but could find little resemblance except in form. The vertebræ of the *Eosaurus* show a much higher degree of ossification than those of fishes; and this extends as well to the non-articular surfaces as to the terminal facets of the centers. In the former, there are none of the cavities which are found in the vertebral surfaces of this class; but the osseous

structure is firm and compact, as in the corresponding parts of the *Ichthyosaurus*. Moreover, the articular faces at the extremities of these centra present no indications of the concentric rings, formed by the partial projection of the osseous laminæ, which so generally exist on the vertebræ of fossil and existing Sharks.

In the comparison of these remains of the *Eosaurus* with those of fishes, the contrast becomes still more marked as we proceed toward the older formations. The ossification of the vertebral column in the Mesozoic fishes was much less complete, and in some orders almost entirely wanting; while in all the Palæozoic species, yet discovered, the notochord was persistent, and consequently no bodies of vertebræ have been preserved. Negative evidence, therefore, would strongly indicate that these perfectly ossified remains should be referred to a higher grade of animals. A microscopic examination, also, of these vertebræ shows that they possess a structure essentially different from that seen in the corresponding bones of fishes; it is, then, evidently necessary, considering all the points of divergence, to reject that class, and place the *Eosaurus* among the *Reptilia*.

From the extinct Reptiles possessing biconcave vertebræ, with which we have to compare these remains, we may at once set aside the orders *Ganocephala* and *Labyrinthodontia* of Prof. Owen; since in these, according to the present state of knowledge, either the notochord was persistent, as in the *Archegosaurus;* or, when a higher degree of vertebral ossification was attained, the neurapophyses were anchylosed to the centrum. Among the Crocodilians, nearly all from the Secondary formations had vertebræ of the amphicœlian type; but, inasmuch as the centrum was terminated by very shallow cavities, and had the superior arch united to it by suture, it will be unnecessary to give further consideration to this group. In the *Sauropterygia* biconcave vertebræ also prevail, but they are all more or less elongated, except in the cervical region of the *Pliosaurus*, where they have nearly the proportions of the present remains. In this case, however, the articular extremities of the centrum were flat, or very slightly concave, and consequently this genus may likewise be rejected.

The remaining orders of extinct Saurians exhibiting the biconcave structure of vertebræ, with the single exception of the *Ichthyopterygia*, differ so essentially, in their known remains, from these vertebræ of the *Eosaurus*, either in the length of the centrum, in the depth of its co-adapted cavities, or in its union with the neural arch, that we may evidently terminate the comparison with the important genus on which that order has been founded.

It will readily be seen from the previous description, that a very close resemblance exists between these vertebræ and those

of the *Ichthyosaurus*. This is especially noticeable in their flattened and subhexagonal form, in their deep and regular terminal concavities, and in the separate state of the neural arch. The differences which exist, however, although of much less importance, must not be disregarded. The most marked of these have already been alluded to; and may be seen in the absence from the sides of the centrum of costal articular surfaces, in the deeper concavities at the vertebral extremities, and in the form and dimensions of the superior arch. The first of these differences would alone be deemed sufficient, by the highest authority, to establish a distinction between these remains and the vertebræ of the *Ichthyosaurus;* for in that genus, according to the statement of Prof. Owen, which is peculiarly applicable to the present case,—"The lower tubercle for the attachment of the rib never wholly quits the centrum: any detached vertebral centrum, therefore, that might be discovered, which had no lateral tubercle or articular surface for a rib, might be safely pronounced, whatever the form of its anterior and posterior articular surfaces, not to have belonged to a true *Ichthyosaurus*, provided it was not compressed laterally, as in the small terminal ribless caudal vertebræ which supported the caudal fin in the *Ichthyosaurus*."* The absence of any lateral compression in the present remains, together with their size and proportions, prove conclusively that they cannot be brought under the exception, which Prof. Owen makes of the terminal caudal vertebræ of the *Ichthyosaurus;* and hence the application of his rule would separate them from that genus.

The points of similarity, then, between these vertebræ of the *Eosaurus*, and those of the *Ichthyosauri*, which they most resemble, clearly indicate that they belong to the same natural group of marine reptiles, and to the same order; while the differences which exist between them seem to be sufficiently numerous and important to authorize the conclusion that they are generically distinct; as might naturally be expected from the vast periods of time that separated their existence.

Since the genera of Enaliosaurians from the Secondary formations, although contemporaneous, differed so widely in form and structure, analogy would lead us to infer that a Palæozoic representative of the family would present still more marked peculiarities in these respects. It is, therefore, particularly interesting to find indications of so strong a resemblance between this primitive saurian and the more recent *Ichthyosaurus*. These fossils, however, present some features of a lower and more ichthyic type of structure than that genus possessed, and it is not unlikely that other parts of the skeleton would show a wider divergence.

* Report on British Fossil Reptiles, Part I, page 102.

These vertebræ of the *Eosaurus*, although the only remains of the genus at present known, are so characteristic and well preserved that they afford considerable evidence in regard to the structure and habits of the animal to which they belonged. They indicate that this reptile, like the later Enaliosaurians, was of great size,* air-breathing, cold-blooded, and carnivorous; that it was aquatic, and probably marine, inhabiting the sea or estuaries; or possibly, as might be inferred from the place of its entombment, the mouths of rivers flowing into the sea.† The flattened form of the vertebræ; the great depth of their terminal concavities; the separate condition of the neural arch; and its short longitudinal extent at the base,—all are consistent with the conclusion that the *Eosaurus* was capable of rapid progress through the water in pursuit of its prey, which was probably fishes; and since it had then, according to our present knowledge, no superior in point of size, it must have reigned supreme in the waters of the Carboniferous era.

As the vertebræ which have been described in this paper were discovered in 1855, they are, consequently, so far as the writer is aware, the first osseous remains of a true air-breathing Saurian from the Coal formation; and the only *Enaliosaurian* remains yet obtained from below the Upper Triassic. Occurring as they do in Palæozoic strata, they add another to the arguments that have been brought against the so-called "Development Theory;" and they show with how great caution we should receive the assertions, so frequently and confidently made on negative evidence alone, of the exact date of the creation or destruction of any form of animal or vegetable life. They prove, moreover, that during the deposition of the Coal-measures the atmosphere was sufficiently free from the destructive gases, which, as many suppose, had contaminated it, to permit the existence of a high type of air-breathing reptiles. This period was, in fact, the foreshadowing of an age, then far in the future, when Reptilian life should hold undisputed sway upon the earth, until in turn supplanted by a higher and a nobler form of existence.

* If we suppose the number of vertebræ and the relative length of the head of this saurian to have been the same as in the *Ichthyosaurus*, its entire length must have been between twelve and fifteen feet, which is at least three times the extent of any reptile hitherto found in Palæozoic strata.

† Although the strata which contained the vertebræ are probably fluviatile or estuary deposits, this would not preclude the possibility of their containing marine remains; as the waters from which they were precipitated were undoubtedly so connected with the sea that an occasional transfer of the inhabitants from one to the other might readily be made: analogous cases are not uncommon at the present time.

Chemical examination of the remains of the Eosaurus Acadianus.

A comparison of the composition of recent and fossil bone is interesting, both in a chemical and a physiological point of view; and has already attracted some attention. As it is desirable to add to the limited amount of data on this subject hitherto collected, the writer has analyzed a portion of a vertebra of the *Eosaurus*, and the results obtained are given below.

A preliminary qualitative examination of the fossils having shown the presence of iron, manganese, copper, alumina, lime, magnesia, potash, soda, organic matter, and water; as well as fluorine, chlorine, sulphur; silicic, carbonic, phosphoric and sulpuric acids, the complete separation of these numerous constituents was necessarily attended with some difficulty.

The following is a general outline of the methods employed in the analysis: The finely powdered substance was first dried over sulphuric acid, and then divided into several portions, between one and two grammes each. One of these was fused with carbonate of soda; and the resulting mass dissolved in dilute chlorhydric acid: the solution was then evaporated to dryness in a water bath, and the silicic acid present was separated and determined in the usual manner. From the filtrate which remained, the copper was precipitated by sulphuretted hydrogen; and, as the amount of this metal in the substance was small, the precipitate was converted into oxyd of copper by moistening it with nitric acid, then ignited and weighed. The lime was next separated from the remaining solution by sulphuric acid, in the presence of an excess of alcohol, and determined as sulphate. When the alcohol had been removed from the last filtrate by evaporation, the organic matter destroyed and the manganese oxydized by chlorate of potash, the solution was made alkaline by ammonia, and the iron, manganese, alumina, magnesia, fluorine, and part of the phosphoric acid present, were thus precipitated. After washing with ammonia water to prevent the solution of the magnesia salt, the precipitate was dried, ignited and weighed. To ensure the complete separation of the phosphoric acid, a weighed portion of iron was converted into the sesquichlorid, and added to the preceding filtrate; the resulting phosphate of iron was then precipitated by ammonia; ignited, weighed, and the amount added to the weight of the previous precipitate. The two were then redissolved in chlorhydric acid, and the phosphoric acid in the substance separated by molybdate of ammonia. This precipitate was next redissolved in caustic ammonia; the phosphoric acid again precipitated by the addition of sulphate of magnesia and chlorid of ammonium, and finally determined in the form of basic phosphate of magnesia.

The quantity of sulphur contained in the substance was not estimated directly; but was calculated from the amount of copper present, with which it was united in the form of copper pyrites, as ascertained by the preliminary examination. The alumina was estimated by deducting the amount of the other ingredients from the weight of the two ammonia precipitates. The manganese, magnesia, chlorine, fluorine, and sulphuric acid were not present in sufficient quantities to admit of accurate determination.

A second portion of the original substance was dried at 100° C. until the weight became constant, and the loss estimated as water. The remaining anhydrous substance was next ignited at a red heat for some time in an open crucible; and when it ceased to lose weight, the organic matter* which it had contained was estimated from the loss, after deducting the amount of the carbonic acid and the sulphur, which had also been expelled. The residue was then treated with chlorhydric acid, the solution evaporated to dryness, and the silicic acid separated as before. The iron, alumina, and phosphoric acid, as well as the traces of manganese, magnesia, and fluorine in the filtrate, were then removed by ammonia. The precipitate thus obtained was redissolved in chlorhydric acid, and the quantity of iron contained in it determined volumetrically by permanganate of potash. The filtrate from the ammonia precipitate was next evaporated to dryness and gently ignited to remove the ammonia salts, and then treated with hydrate of lime. From the filtrate which remained the potash and soda were obtained in the usual manner, and first weighed together as chlorids: they were then redissolved, and their respective amounts calculated from the quantity of chlorine in the solution, which was determined volumetrically by nitrate of silver.

In a third portion of the original substance the carbonic acid was estimated in the usual way, from the loss of weight after treatment with dilute chlorhydric acid.

The material taken for analysis was part of a segment from the lateral surface of the vertebra, which remained after preparing the microscopic sections. The following were its physical characters: Compact, with uneven fracture. Hardness, 3·5. Specific gravity at 20° C., 2·78. Lustre dull. Color brown. Opaque.

* It is not unlikely that a portion of the loss by this process was merely water, so combined with some of the constituents of the substance that it was not expelled below the heat of ignition.

The results of the analysis were as follows:

Water,		·82
Organic matter, and combined water?		2·39
Peroxyd of iron,		10·21
Protoxyd of manganese,		*trace.*
Alumina,		20·15
Lime,		24·96
Magnesia,		*trace.*
Potash,		·39
Soda,		1·10
Copper pyrites,	copper,	1·22
	iron,	1·07
	sulphur,	1·20
Fluorine,		*trace.*
Chlorine,		*trace.*
Phosphoric acid,		11·40
Carbonic "		20·89
Silicic "		5·04
Sulphuric "		*trace.*
		100·84

The matrix of the fossils was an argillaceous shale, colored with peroxyd of iron; and without doubt many of the constituents of the remains were derived directly from this source by infiltration, the silicic acid, alumina, peroxyd of iron, and alkalies, resulting from the decomposition of clay.

The small amount of manganese in the substance was found to exist as protoxyd, and was probably combined with a part of the silicic acid. Protoxyd of iron also was present, but its separation from the higher oxyd, being in this case unimportant, was not attempted: the estimated quantity of the peroxyd given above is, consequently, somewhat greater than the true amount. The protoxyd of iron, as well as part of the lime, probably existed in the fossils as carbonate. The phosphoric acid was undoubtedly combined with the iron and lime.

The fluorine in these vertebræ was in smaller quantity than has generally been found in fossil bones, and differs widely from the amount obtained by Baumert, who found 16·67 per cent of fluorid of calcium in the remains of the *Zeuglodon*.* The results of the present analysis tend to confirm the opinion of Middleton and others that the presence of fluorine in fossil bones is accidental; and that the large amount of this substance occasionally found is due to infiltration; and is not, as some writers have affirmed, an original constituent of the remains.

The organic matter in these remains may have been partially derived by infiltration from the fossil plants contained in the surrounding matrix of shale: a careful examination, however,

* Liebig und Kopp, Jahresbericht für 1851, p. 594.

seemed to indicate that a portion of it was of animal origin; and this has probably been preserved from the original substance of the vertebræ.

The estimation of the organic matter in many analyses of fossil bones, which have been published, is based on the loss by ignition. This method, if alone employed, as is usually the case, is liable to give very erroneous results, especially where the quantity of organic matter is small; since the mineralizing substances, introduced into the fossils by infiltration, not unfrequently may contain in close combination a considerable amount of water, which remains at temperatures much above those ordinarily used in desiccation. Loss by ignition, therefore, in analyzing such remains, is no proof of the presence of organic matter; and the results thus obtained are worthless in this respect, unless the existence of this substance has been otherwise ascertained. The nature of the organic matter also should be determined; as in animal remains from the older rocks it is occasionally due to infiltration, and may be entirely of vegetable origin.

In the present analysis the following method was employed for the detection of the animal organic matter supposed to be present in the fossils: A portion of the finely powdered material, between one and two grammes in weight, was placed in a beaker, and a small quantity of distilled water added; the vessel was then closely covered, and left on a sand bath where the temperature was just sufficient to cause a gentle ebullition. The heat was continued, and the water renewed from time to time, for several days, to effect the solution of any animal organic matter the fossils might contain. The insoluble portion was then filtered off, and the liquid evaporated to dryness in a platinum capsule, when the residue, on gentle ignition, carbonized, and distinctly afforded the characteristic odor of burning nitrogenous tissue. This, or some equivalent method of proving the presence of animal organic substances, should always be employed in analyses of this kind, especially where a complete separation of the organic ingredients is not attempted.

A nitrogen determination was made on a portion of the material somewhat different from that used in the preceding analysis, and gave ·776 per cent. for the amount of that substance in the remains. This corresponds essentially with the results obtained by M. Delesse, who has made somewhat extensive researches on this point; and who considers that the quantity of nitrogen in fossil bones is, within certain limits, a reliable indication of their age.* The substance used in the above determination was evidently different from that previously employed; as the amount of nitrogen obtained would indicate a much larger quantity of gelatigenous tissue than the analysis showed to be

* Comptes Rendus de l'Acad. des Sci. de Paris, 1861, tome lii., p. 728.

present in the portion first examined. Part of the nitrogen may have been derived from ammonia, which is sometimes introduced into fossils by the infiltrating waters. A want of sufficient material prevented fuller investigations of the organic elements in these remains.

The fossil bones hitherto analyzed appear to have been all from the more recent formations; the present analysis, however, of a Palæozoic fossil does not differ materially in most respects from the results previously obtained.

Yale College, April 15th, 1862.

EXPLANATION OF THE PLATES.

PLATE I.

Vertebræ of the Eosaurus Acadianus (natural size).

Figure 1. Oblique lateral view of the vertebræ, with the posterior articular surfaces above.

a. Pits for the articulation of the neurapophyses.

b. Rudimentary transverse process on the right lateral surface of the centrum.

c. Notch, or depression, in the posterior margin of the centrum.

Figure 2. Oblique view of the vertebræ, with the anterior articular surfaces in front.

a, *a'*. Pits for the articulation of the neurapophyses.

b. Rudimentary transverse process on left lateral surface.

b'. Ditto on right lateral surface.

PLATE II.

Vertebræ of Eosaurus (natural size), *with magnified sections.*

Figure 1. Posterior view of the more perfect vertebra.

a. Pits for articulation of neurapophyses.

b. Rudimentary transverse process on left lateral surface.

b'. Ditto on right lateral surface.

c. Notch, or depression, in the margin of the centrum.

Figure 2. Transverse section of the same vertebra, showing the deep concavities of the articular terminal facets, and the rudimentary processes at *b* and *b'*.

Figure 3. Longitudinal microscopic section, from near the lateral surface of the centrum, showing the elongated lacunæ arranged concentrically around an Haversian canal. (Magnified 350 diameters.)

Figure 4. View of the reticulated osseous texture on the lateral surface of the centrum. (Magnified five diameters.)

Figure 5. Transverse microscopic section, from near the articular surface of the centrum. (Magnified 350 diameters.)

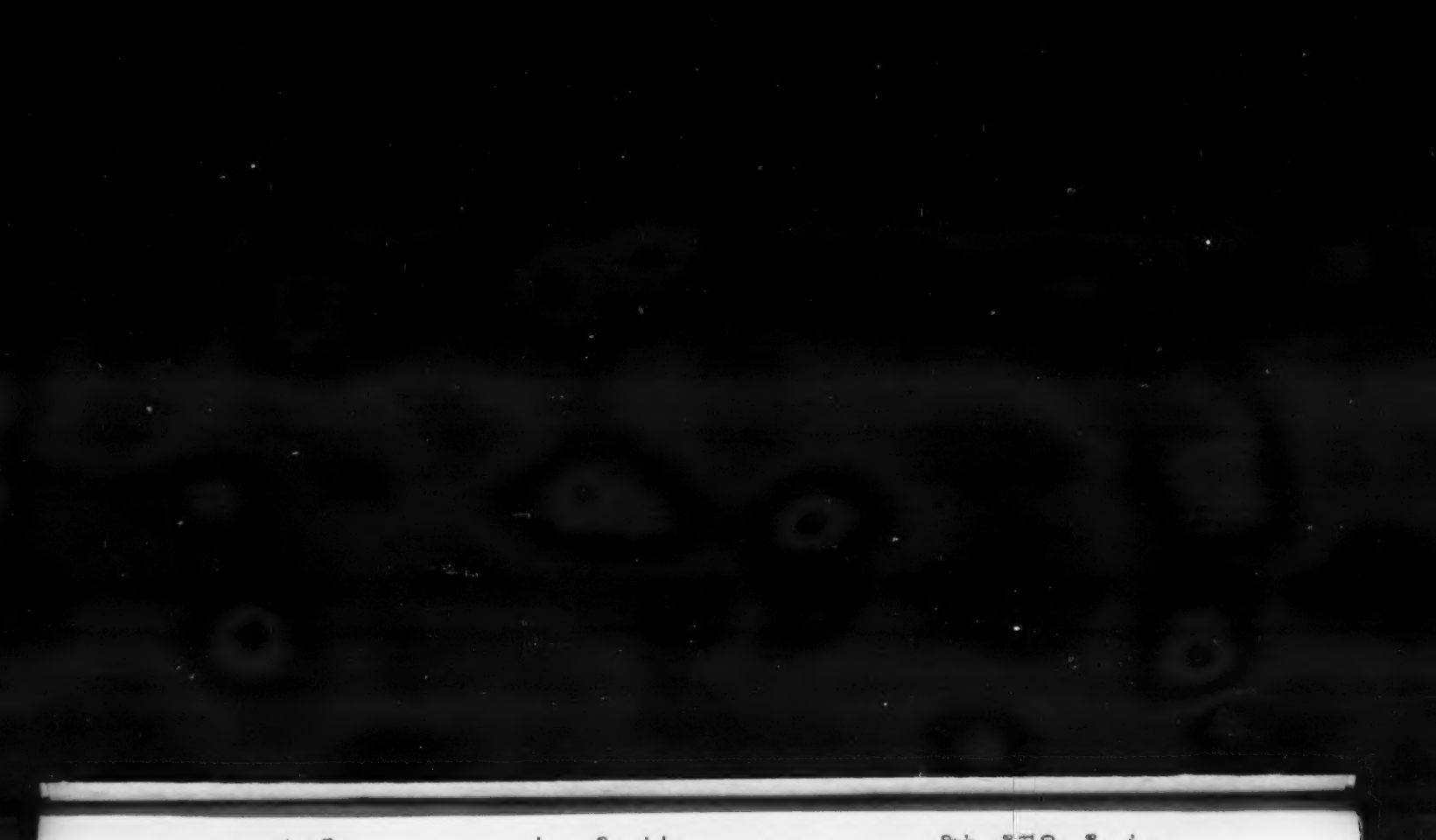

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Photo by M.W. Fylley

Eng.d by A.H. Ritchie

VERTEBRAE OF EOSAURUS ACADIANUS.

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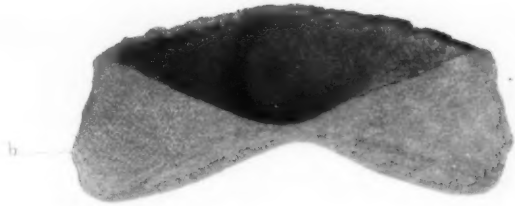

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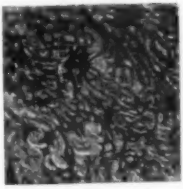

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Photo. by M. W. Filley.

Engd. by A. H. Hoskins.

VERTEBRAE OF EOSAURUS ACADIANUS.

ART. II.—*The Physiology of Sea-sickness;* by RICHARD MEADE BACHE, Assistant U. S. Coast Survey.

(Read before the Connecticut Academy of Arts and Sciences, January 15, 1862.)

ALL that is known about sea-sickness is, that certain involuntary motions of the body produce an effect upon the nervous system. This effect results in nausea. This nausea is called sea-sickness. The question is not solved, as to the manner in which the nervous impression is produced. It is generally supposed, that sea-sickness is produced by the mere motion of the body, and consequently of the stomach. That it is produced by motion, is not to be denied, but as wherever sea-sickness occurs, motion is the pervading concomitant of existence—the thing most patent of all that is evident to the senses, and the body is so unpleasantly subjected to it, we lose sight of the fact, that with the body are also subjected all the senses or perceptive faculties, and that these are called upon to comprehend an entirely novel state of existence.

I have said, that the mere action of motion upon the body is supposed to produce the nausea called sea-sickness. I hope to be able to overthrow this theory by the arguments and proofs of another theory, which I am about to advance.

The points which I intend to prove are—that the agreeableness of motion is a mere matter of habit—that motion however violent is not nauseating "per se" but only inasmuch as it produces an impression conflicting with its ordinary contrasted effects as pre-established in the mind, that the idea of motion is the result of concurrent testimony of the senses—and, that in novel motions, there is a violation of the conception of motion derived from the habitual concurrence of the testimony of the senses—that as the result of this violation, a conflict of impressions ensues, and the brain is affected—thence the nervous system, and nausea results. In fine, I maintain that sea-sickness is a disease of the brain, and not of the stomach, except incidentally, or as affected by the brain, although, it is true, that the stomach reacts upon the brain.

I now commence my argument in which I have attempted a procedure, which, I trust, cannot fail to bring conviction of the truth of the theory to any one who will carefully analyze it. In all statements of facts which I have introduced I have taken the experience of others, as well as my own.

The appearance of motion when the observer knows that his own body is at rest, is not nauseating. To ascertain the effect of the mere appearance of motion under these circumstances, we can take no better example, than that of a train of cars drawn by a locomotive at full speed. The more rapid motions of the

heavenly bodies are not appreciable by our senses. We have conception of them through the mind, but not through sight or hearing, therefore I have chosen the motion of railway trains for the purpose of illustrating the effect of the mere appearance of motion. Standing as near, or as far off, as one pleases, from a train of cars in rapid motion, no more nauseating effect is produced upon the spectator, than by the sight of any object at rest. Yet the appearance of motion is nauseating in *two* cases—but these are where the idea of motion of the body is involved, that is, where motion of the body of the observer is either in *debate* by the mind, or *acknowledged* by the mind and the motion is not *felt*. If this can be made to appear, it is additional proof, that the mere appearance of motion is not nauseating, or as I shall henceforth express it for convenience, the appearance of motion is not nauseating "per se." As an example of the first case—that the appearance of motion is nauseating "when motion of the body of the observer is in *debate* by the mind"—take the following: In a dimly lighted depot, two trains of cars stop side by side—presently one starts—so gently that an occupant of one of the trains cannot decide whether it is his own train which is in motion, and consequently whether it is his own *body* which is in motion or whether the motion perceived, is that of the other train. This produces a sensation of uncomfortableness—of giddiness—indicative that nausea would result if the effect were continued. At all events, it produces an impression of motion of the body, which impression is derived through the instrumentality of the sight, and which impression affects the nervous system unpleasantly—yet the body of the observer may have been at rest all the while. As an example of the second case—the assertion "that the appearance of motion is nauseating when motion of the body of the observer is *acknowledged* by the mind, and the motion is not *felt*," one illustration, as in the first case, will suffice. In the slight trembling of an earthquake, when the jar would have escaped notice, but for the faint oscillation of a chandelier which calls attention to the existence of an earthquake—this oscillation through the impression which it gives the observer, that his body is in motion, often causes the sensation of nausea. It is impossible that the motion of the body of the observer could cause the sensation, for the case spoken of is one where the existence of the earthquake would not have been known, but for the oscillation of the chandelier. The sensation could not have proceeded from the mere perception of the motion of the chandelier, because such an object can be viewed while swinging violently, without any sensation being produced, other than the perception of its swinging.

The cause of the disagreeable sensations just described, is owing to the fact that nature requires our senses to keep pace. The sight must not proclaim what the feeling does not at once cor-

roborate and "vice versa." In the first case, nervous impression was produced by doubt in the mind of the observer as to whether his body was or was not in motion, and in the second case, by the consciousness of motion of the body, which motion was not *felt*. In neither case, did the senses keep pace, consequently the nervous impression ensued, and consequently nausea. It is evident, although the sight was the agent in these results, that it was *only* the agent, and it was the imagination which produced the effects. Sight was the intermediary. It may be safely inferred from the effect of the appearance of motion in the two cases just cited—that if a man believing himself in his senses, should see a landscape glide by, he would become nauseated, yet it is evident that the nausea would proceed from the involved idea of motion—the idea that he might be in motion without feeling it—for if he knew it was only the landscape which he saw that was in motion, he would regard it with terror, but without other sensation, and it would affect him as a passing train of cars when he knew that his own body was at rest—that is, it would not affect him at all, as far as nauseation is concerned.

We see then, that the appearance of motion "per se" does not nauseate, and we see too, how the nervous system is impressed by the imagination so as to bring about nausea.

The senses from the earliest infancy have grown up and been educated together, to act in harmony. It requires habit to render them capable of keeping pace together in a novel condition of existence. The motion communicated to the body by riding in a carriage, is by no means violent, notwithstanding which, persons in early life, frequently become nauseated while thus riding. This is merely because the sense of sight and the feeling of a certain motion have not been educated together. This I shall proceed to show. It is well known, that persons perfectly habituated to riding in a certain position in a carriage, object to riding with the back towards the direction in which they are proceeding, on the plea that it makes them sick to do so. It doubtless has that effect, but it is impossible for the effect to be produced by the mere motion in that position, for it is impossible in a carriage in motion in the dark, to decide in what position one is sitting in relation to the line of progress, unless some obstacle should interpose, or the road should be so bad as to afford an equivalent to a number of obstacles in the way, or unless the driving is of such a character, by sudden turnings and abrupt increasing or slackening of speed, as to indicate to the occupant of the carriage the position in which he must be sitting. In a word, in ordinary conditions of progress in a carriage, it is impossible in the dark to determine in what position one is sitting. This is not generally known. Experiment will prove my assertion to be true.

It has been already shown, that the appearance of motion "per se" does not nauseate. How then is a person accustomed

to riding in a carriage, nauseated by riding with the back towards the direction in which he is proceeding, for the appearance of motion "per se" does not nauseate, nor can motion "per se" nauseate in *that* instance. The effect is derived from consciousness of motion perceived by two senses at least, while at the same time, the appearance of objects violates the habitual impression produced by the sight of them. In the dark, the effect must be derived from pure imagination. If we grant then, that a particular mode of progress in a carriage can nauseate one accustomed to a carriage (and it is often seen) and we grant at the same time, that appearance of motion "per se" is not nauseating (and this I have proved) and we know also, in the case spoken of, that motion "per se" could not have produced the sensation of nausea (because the motion is the same in any position, and the person is habituated to one) we must then acknowledge that the nausea is produced neither by the motion "per se," nor by the appearance of motion "per se," but by a conflict of the two senses of feeling and sight. If this can be inferred in the case of one accustomed to the motion of a carriage, it must apply with more force to one unaccustomed to it.

So thoroughly have the senses created a conception of motion, that the exclusion of sight does not alter the idea of its appearance, nor alter the idea of the appearance of violation of preconceived effects. The mental picture is always present. If the exclusion of the sight did alter these ideas, the closing of the eyes would in one of the cases just mentioned, save from nausea a person unaccustomed to riding in a certain position, and in the other case, would secure immunity from nausea to the person unaccustomed to riding at all. But it does not save them, which shows that the mental picture of progress and of unwonted effects, takes the place of that produced by actual vision. It is immaterial whether the sight is acting or not acting. Whatever senses exist in an individual, have conjointly created a well defined idea of the contrasted effects of motion, and this conception is always evident to the mind without the continued intervention of all the authors of the conception.

Having shown that a certain motion is nauseating, but is not nauseating "per se," we may fairly infer that no motion is nauseating "per se." Perhaps in very violent motions, there may be some mechanical effect produced by the movement of the stomach—this is not a primary cause of sea-sickness, but an aggravation of it. Otherwise, it must be supposed that the stomach of a sailor becomes entirely changed in its nature.

The law to be deduced from what I have attempted to demonstrate is this—that the violation of the habitual conception of contrasted effects of motion, is the cause of the nauseation which occurs during novel motions—and the cause is not motion "per se," nor the appearance of motion "per se."

If such effects as those just described in the case of riding in a carriage can nauseate, when they are produced by comparatively slight changes in "the habitual conception of contrasted effects of motion" it is not surprising, that the effect of motion at sea should bring the great and continuous nausea called sea-sickness. The motions of a ship vary infinitely. As soon as a certain kind of motion has lasted for a long time, the voyager becomes accustomed to it, and he has no more tendency to become nauseated, than has the man accustomed to a carriage. He may, however, become sick again, if the motion should vary, and yet not be increased. A person habituated to the sea, may remain ashore for a long time, but his senses readily accommodate themselves again to conditions once understood. It is true, that even old sea captains are sometimes afflicted by sea-sickness, but this does not invalidate the theory which I have advanced. There are temperaments so predisposed to sea-sickness, that the inuring process has to be perpetually renewed. I do not assert, that the same amount of experience at sea, gives the same immunity to each person. The causes which I have mentioned as superinducing sea sickness affect every one, but the capability of resisting it varies with every temperament. There are individuals who never become sea-sick—that is to the extent of succumbing to nausea—but they undergo the same process of education of the senses. The difference between these persons and those who do succumb, is that their organizations in physique and temperament enable them to resist the inclination to nausea and the education of the senses is completed before nausea has been able to overcome them, although it always attacks. There is no one, who in a first experience at sea, is not disposed to nausea, but there are some few persons, who possess such organizations, that with the aid of a firm determination to resist an attack of sea-sickness they are enabled to escape it, and to pass the ordeal of the novel motion at sea without manifest inconvenience.

At sea, motion immediately nauseates, even when it is much less than may be experienced in a swing without the slightest impression. In a swing, motion is comparatively regular. It requires little education of the senses to enable them to keep pace with each other. The evidence of the sight is nearly the same as that of the feeling. If a person in a swing is blind, or keeps the eyes shut, there are still measures of the extent of motion. These measures are firstly the points of highest elevation and greatest depression—secondly, the corresponding intervals of time—thirdly, the perception of the rush in progressing through the atmosphere, for not only does the cessation of the rush indicate the points of greatest elevation, but its increase or diminution, indicates continuously all other points. Hearing may also be mentioned, as it contributes to the conviction of the mind as to

the uniformity of the motion to which the body is subjected when swinging. All these certainly give a most accurate idea of the segment of a circle which the body is describing in the air. Nausea can be produced in a swing, but it requires very little education of the senses to enable a person to bear the motion.

I have been told by a person who attempted to prepare himself for a sea voyage by using a swing, that the process was entirely unavailing—yet I doubt very much, whether the motion to which one is subjected at sea, is often greater than can be attained in a well constructed swing. But the motion of a swing is quite uniform—that at sea far from it, and the failure of the swing to inure a person to unequal motion, shows that it is not motion which affects us, but inequality of motion, and that it is not the mere mass of flesh and digestive organs which are alone concerned, but other elements as appurtenances of the body demand our consideration, and as I hope to prove, merit it, far more than the mere body and stomach, which becoming diseased only react. If it be said, that animals, such as horses and dogs, become sea-sick, and yet have no such nice senses as we have, excepting perhaps scent;—I answer by saying, that a horse is always terrified at movement in which he does not see the cause, even terrified at perfectly noiseless movement. What is it which prompts a young dog to jump at all hazards from a vehicle in rapid motion, even when driven by his own master, and what makes him eventually delight in riding? Preconceived ideas of motion when violated bring terror to both horse and dog. The conditions of novel motion, once accepted, the senses are reconciled and habit is the result. If then we allow these animals to possess habitual conception of motion, they must be affected at sea as human beings are—in the same manner if not in the same degree. The tumbler pigeon precipitates itself with a revolving motion towards the earth, but does not appear to be at all affected by the motion which its body has undergone. If the same bird is taken in the hand and its head placed under one of its wings and it is then whirled around, it may be placed on a table, and during a few moments it will appear lifeless. Aquatic birds of the greatest vigor in flight, and habituated to floating on stormy waves, often become nauseated on the decks of vessels.

Let us now consider the motions at sea. A ship rolls, plunges, seems to pause, then dart, and every movement brings the passenger increased uneasiness. There is no precedent in his experience for such movement. If he possesses sight, the view of objects is at variance with all that he has been habituated to in other motions. If he is blind, his mental conception—the picture in his mind—is equally at variance with his habitual conception. In a few days, in either case, the person would be indifferent to the motion. He will have learned, in the mean-

time, to reconcile the evidence of his senses. If he possesses sight, it will have been educated in conformity with unequal motions, just as it was educated from childhood to comparatively equal ones, or if he is blind, his conception of the appearance of motion, will have been reconciled with motion experienced. In either case, it is the conception of the appearance of motion, as contrasted with the feeling, which conception will have reconciled itself with existing conditions. Both those who see, and the blind possess this habitual conception, which is never shut out from the mind as has been shown. Closing the eyes will not discard it. If it did, every one subjected to unusual motion could in that way, secure immunity from nausea. This has been shown not to be the case.

Let us now consider the peculiar effect of unequal motions upon the human body. It is my conviction that motion is nauseating whenever the estimate of its extent does not correctly precede it. The mind mechanically calculates what is to take place while it is taking place.

I shall now endeavor to show, that "motion is nauseating whenever the estimate of its extent does not correctly precede it." I have already shown that motion is not nauseating "per se." I have also shown, that when it does nauseate, it is when the brain is impressed. The question naturally suggests itself here, as to what there is in the impression produced on the brain which affects us unpleasantly and produces nausea. It is the idea of undefined movement of the body of the observer. Back of this I do not pretend to go. Nature has so constituted us, that undefined motion is repugnant to our organizations. Nauseation from motion proceeds from the idea present to the imagination, that the body is the subject of undefined motion. The nauseation of sea-sickness, of course, eminently proceeds from undefined motion. But to the proof—an experiment which any one can make. I have often lain awake at night in the cabin of some great ship at sea, and guaged the motion and calculated the capability of the passengers to resist an access of nausea. Choose a time, when there is a regular sea and wind, when the ship ploughs along pretty evenly. Now and then, seas will rise somewhat higher than the rest. Sea-sick passengers habituated to uniform motion—at the intervals when the ship has been accustomed to rise or to fall, feel that they rise still higher or fall still lower. The difference in motion is not perceptible in violence, and yet causes many to give involuntary evidence of the occupancy of their state rooms. The strain of fancy is ever exerted and *solicitous* to imagine and attain the turning point, although after it is gained, the motion, as in a descent, may be still more rapid. Let any one who has been at sea, recall how trying was a continuous movement in one direction, even a long rise upon a wave, when the motion is certainly not as swift as in

a descent, and at the same time remember, how small the motion of a long gliding rise or descent is, as compared to much that one is subjected to at sea—how much less violent. The effect upon the observer is produced simply by the difference of motion —by ignorance of the extent to which it is going—by the idea of undefined motion. When one's senses are educated in the novel condition of existence at sea, the motion is no longer undefined. A ship could make no movement which would not be accompanied by a corresponding idea of space passed through. There is no motion at sea which by habit will not cease to appear undefined, but if it were possible for a ship to mount heavenwards, and to sink rapidly near to the bottom of the sea in alternate movements, it is my belief, that the hardiest sailor would become sea-sick.

The summary of what I have attempted to demonstrate is this, that sea-sickness is not the result of motion "per se," nor of the appearance of motion "per se," but is the result of the senses "violating the habitual conception of contrasted effects of motion" and producing on the brain the idea of undefined motion. When the senses are educated to form coöperating and agreeing measures of the novel condition of existence at sea, nausea ends. If they never formed these measures nausea would never end.

For another proof of this theory, take the case of an infant. Instances of children in arms being sea-sick are very rare.* A child certainly feels the motion, that is to say its body is subject to the motion equally with that of the oldest passenger. But a child undergoes motion without *feeling* it. It sees too, without *perceiving*. In its case nothing conflicts. It is as ready to be rocked on the billows as in its cradle. Its youth precludes the possibility of its having any habitual conception of motion from the education of the senses, and if it feels any sensation, that sensation is at variance with nothing. As soon as children begin to "take notice," as it is called, the education of the senses begins, and thus we find, that children shortly afterwards, at the age of two and three years, are attacked by sea-sickness, but they recover long before adults are secure from it. The case of a blind man, because he cannot see, and consequently cannot perceive, is not

* A medical friend has handed us the following note on a case of his own observation.—Eds.

While I was surgeon on the emigrant packet ship "Webster," (1861,) I recollect a case of a girl (an infant) at the breast dying of sea-sickness. The child was perfectly healthy when passed by the Inspecting Medical Officer in Liverpool, and continued to be so, apparently till after we discharged our Pilot at Holy Head. On the evening of the first day out, it was very rough and blowing hard, and consequently a large number of passengers, both adults and children, were afflicted with sea-sickness (Morbus Nauticus). They all eventually recovered with the exception of this child. It had all the symptoms of sea-sickness, such as loss of appetite, vomiting, a cool clammy skin, tongue thickly coated in the middle, and a weak feeble pulse. In spite of good medical treatment, it continued to fail rapidly with debility, till we arrived in long. 27° when it died. Dr. E. S. Bissell.

in any respect similar to that of an infant, for I have shown, that the mental picture may conflict with reality, and the blind man has the mental picture—the idea of space—motion—speed—everything—excepting color. Not only are babies not usually afflicted with sea-sickness, but just in proportion to the youth of children, are they exempt from it. Since my own observation indicated what has been asserted in regard to the immunity of babies from sea-sickness, I have enquired of persons of experience, whether their observation tended in the same direction, and I have been confirmed in my belief.*

It has been asked by a friend, to whom I communicated this theory of sea-sickness, whether the insane are sea-sick, and an answer in the negative would certainly seem to corroborate the theory. Thus far, however, I have been unable to ascertain, as the insane are so rarely allowed to go to sea, that it would require long and patient investigation to determine the point. Immunity from sea sickness in a very few cases might be a mere coincidence. As far as the answer has been made to my enquiries, I shall give the result. I know of two persons, who, there is every reason to believe never had been at sea until a voyage, when they labored under the "mania à potu." These persons did not become sea-sick. Another case of which I have reliable information, is that of a young girl, who was insane, and who was taken

* Among the latest testimony which I have received, is a letter written by Captain R. P. Manson of Bath, Maine. This letter is subjoined. Much other testimony has been received verbally, or is my own testimony derived from close observation and comparison during a series of years. The remark that it is impossible, in a carriage in motion in the dark for the occupant to decide in what direction he is sitting in relation to the direction of progress, is one which I heard made by my father many years ago, at a period when I was but a child. Memory treasured this alleged fact, and not suspecting for a moment, that the determination of its truth would ever be of any service, beyond the mere verification of a curious fact, I was able subsequently to investigate it, and to ascertain its entire correctness, and now it forms a very important link in the chain of evidence which I have adduced in support of my theory of sea-sickness. I have often received the testimony of others on various points, by merely listening to their descriptions of certain sensations, and thus I was generally enabled to avoid what might prove leading questions.

Letter of Capt. R. P. Manson.

Bath, Oct. 14th, 1861.

R. M. Bache, Esq.,

"*Dear Sir*:—Your letter regarding sea-sickness has been received, and I most cheerfully comply with your request—offering any information (which has come under my observation during thirty years actual services as shipmaster mostly in the European business) which you may deem relative or interesting to that subject.

In answer to your questions regarding children—I have never known an infant, nursing—sea-sick, and children from the age of two and a half up to four or five years, are not often sea-sick, when so, the attack is but short, slight, and seldom returns. Such, I believe, is in conformity with your own views: it is what I have invariably observed with many hundred emigrant families.

I will mention I once knew one of the worst cases of sea-sickness completely and almost instantly cured by fear. Respectfully your ob't serv't,

R. P. Manson."

to sea by her father, who was the captain of the ship. She too was not sea-sick. I should be very sorry to mar a strong case of evidence in favor of the theory which I have advanced, by an assertion of the truth of which I am not positive, even if I were willing to state any thing of which I am not absolutely certain. I give my investigation of this subject, for what it is worth in the thoughts of those who may read this article. I shall not support my theory in any measure whatever upon the result of that slight investigation. Therefore I do not assert, that the insane are not liable to sea-sickness.

I think it sufficiently clear from all that has been said, that impression of the brain is the cause of nausea on the ocean, since I have shown, that it is not motion "per se" nor the appearance of motion "per se" which causes it, but an *idea*, which I have termed one of undefined motion, derived when the body is subjected to motion in an unusual manner, from the "violation of the habitual conception of contrasted effects of motion." There are minor causes of sea-sickness, or rather, not so much causes as aggravations of it. These are close cabins, smell of bilge-water, unusual food, and as I have said, the stomach reacts upon the brain.

A precaution frequently taken by people about to commence a sea-voyage, is to eat nothing or scarcely any thing. Another precaution taken, is to get immediately into a berth. Neither plan is good. Neptune is the most insatiable highwayman on the globe, and attempts to levy toll on all. The traveller who comes totally unprovided, fares badly, if he cannot successfully resist. In plain English, the stomach is weakened by want of food, and is therefore more liable to be acted upon in the production of nausea, and if nausea should ensue, retching is probably more distressing without than with food. Lying down is an excellent plan to adopt for the purpose of avoiding nausea, but when the posture is assumed in a berth with the nauseous smell of bilge water around and as is often the case, with a tin vessel of questionable nicety, hooked on the edge of the berth, the plan is no better than the first.

Persons frequently imagine that some particular article of food cured their sea-sickness. It is a general rule, that whatever a sea-sick person is able to eat at all while sick, or convalescent, gets the credit of the cure. The most heterogeneous articles are spoken of as specifics. The best preparation to avoid sea-sickness, is to go aboard ship with the stomach supplied with its accustomed amount of food. It is best, as far as possible, to maintain the habits of shore.

Many reasons combine to render the deck of a vessel in any thing like fair weather, the proper place to remain, either to avoid sea-sickness, or to recover from it. It is there, that the

sight can be more quickly educated to the movement, than it can be in the cabin. The crests and troughs of the seas can be observed, and thus it can be seen, just how far one has to rise—just how far to fall. Persons will frequently find, that the view of the waves has a beneficial effect in stilling nausea, suffered more severely in the cabin. This is not only on account of the fresh air on deck, but because in the cabin, the idea of motion is more undefined. The view of the horizon also, has a most beneficial effect. The horizon is the only object which has the appearance of remaining stationary, and the motions of a ship are readily graduated by keeping the gaze directed to it. On deck the miserable sea-sick passenger can breath the fresh air, in lieu of the conglomerate smells in a cabin aboard ship. He can also choose a position amid-ships, where there is the least motion of any place on deck. Then there are more agreeable objects to look at on deck, and beyond, than in the cabin, and it is very important that the mind should be distracted from the passing scene—or, what is disagreeable or most so in it. In a foot-note, I have adverted by a quotation to a case, where a woman who had been prostrated for some days by sea-sickness, was immediately and completely cured, owing to the action of terror on her mind, resulting from the belief that the ship was foundering, and this case is by no means isolated.

If in addition to what has been recommended, the passenger will spread a mattress, and put himself in a recumbent posture, all will then have been done, that can be done, to prevent, to cure, or to alleviate sea-sickness, until the education of the senses is completed.

ART. III.—*On the Empirical Interpolation of Observations in Physics and Chemistry;* by W. P. G. BARTLETT.

THE object of the present paper is to bring to the notice of physicists some methods of interpolation; not that there is any principle in them new to mathematicians, but because no proper methods appear to be practically within the reach of many of those engaged in making such observations in physics and chemistry as require interpolation.

Whatever difficulty there is in the problem arises from our entire ignorance of the form of the function which the observations follow, and from the necessarily irregular intervals at which they are made.

Every method of interpolation under these conditions amounts to *assuming* some formula involving arbitrary constants, and determining the values of these by elimination from the equations furnished by the observations.

If all the observations are required to be rigorously satisfied, Lagrange's formula,

$$y=\frac{(t-t_1)(t-t_2)(t-t_3)\dots}{(t_0-t_1)(t_0-t_2)(t_0-t_3)\dots}y_0+\frac{(t-t_0)(t-t_2)(t-t_3)\dots}{(t_1-t_0)(t_1-t_2)(t_1-t_3)\dots}y_1$$
$$+\frac{(t-t_0)(t-t_1)(t-t_3)\dots}{(t_2-t_0)(t_2-t_1)(t_2-t_3)\dots}y_2+\text{ \&c.},$$

is probably as good a way as any of arranging the elimination, since it is only necessary to multiply the various factors to obtain the function y, developed in powers of the variable t; y_0, y_1, &c., being the observed values corresponding to the values t_0, t_1, &c., of t.* Otherwise the determination of the constants may be made either so as to satisfy exactly some of the observations, or so as to satisfy them all within moderate limits—say the probable errors of the observations themselves. The former proceeding is theoretically imperfect, because it makes some of the observations of no account whatever in determining the values of the constants, using them, if at all, only to help the selection by successive trials of the form of the function. The latter is generally impracticable in a direct form, unless the constants enter linearly into the equations, in which case the method of *least squares* will always give good results; but if besides this, the successive terms in the development, either of y, or of any given function of y, form a convergent series, it will generally be advantageous to use Cauchy's method, which, *notwithstanding its violation of the law of probable error*, is practically sufficient, and indeed far the best, for almost all the physical formulæ that it is worth while to develop at all in an *empirical series*.

This method not being, like *least squares*, generally accessible in a working form, it is proposed to devote special attention to its operation. Its principle is to neglect at each step all the terms of lower orders, leaving in general a form

$$z=a\,u,$$

and then of all the values

$$\frac{k_0z_0+k_1z_1+k_2z_2+\text{ \&c.}}{k_0u_0+k_1u_1+k_2u_2+\text{ \&c.}}$$

which might be given to the constant a, by assigning different sets of values to the k's, to select that in which the k's are all so taken ($=\pm1$) that the denominator above written becomes the

* If there are $m+1$ observed values of y, there will be only $\frac{1}{2}m(m+1)$ *different* factors to be computed in all the denominators of the formula above written; and it is evident from the theory of equations, that the coëfficient of t^{m-r} in the numerator (expanded in powers of t) of the coëfficient of y_n will be $(-1)^r$ times the sum of the products formed by every possible combination of r different factors, t_0, t_1, &c., *omitting from the sum the terms containing* t_n; which involves for the whole work only $2^{m+1}-(m+3)$ different products of two or more terms each, and therefore only this number of multiplications.

absolute sum of the special values of u.* To show more distinctly how the numerical application is to be made, we shall here arrange some formulæ for computation, changing for this purpose some of Cauchy's notation and giving the development an entirely different form.

Let it be assumed, as usual, that the observed quantity y, converges when developed in the form

$$(1) \qquad y=A+Bt+Ct^2+ \&c.$$

If this assumption does not give, on trial, a convenient formula, the logarithm or any other function of y may be tried in the place of y, and its development made in precisely the same way. It will be easy to see, moreover, that any variables we please may be substituted for the different powers of t, *provided only the series is convergent.* The function will first be developed in the form

$$(2) \qquad y=\mathfrak{A}+\mathfrak{B}\Delta t+\mathfrak{C}\Delta^2t^2+\mathfrak{D}\Delta^3t^3+ \&c.$$

in which Δt, Δ^2t^2, &c., are functions of the form $a+bt+ct^2+$&c. and are respectively of the first, second, &c., degrees in t. The numerical values of $\mathfrak{A}$, $\mathfrak{B}$, &c., and the expressions for Δt, &c., being found, the series (2) is immediately reducible to the form (1). Let s be the number of observations given to determine A, B, &c.; then the formulæ required in practice are

$$(3)\quad \left\{\begin{array}{ll}
\alpha_1=\dfrac{\Sigma t}{s}, \quad \alpha_2=\dfrac{\Sigma t^2}{s}, \quad \alpha_3=\dfrac{\Sigma t^3}{s}, \ldots\ldots\ldots\ldots \alpha_n=\dfrac{\Sigma t^n}{s} & \\
\Delta t=t-\alpha_1, \quad \Delta t^2=t^2-\alpha_2, \quad \Delta t^3=t^3-\alpha_3, \ldots\ldots \Delta t^n=t^n-\alpha_n & \\
\beta_2=\dfrac{\Sigma'\Delta t^2}{\Sigma'\Delta t}, \quad \beta_3=\dfrac{\Sigma'\Delta t^3}{\Sigma'\Delta t}, \ldots\ldots\ldots\ldots \beta_n=\dfrac{\Sigma'\Delta t^n}{\Sigma'\Delta t} & \\
\Delta^2t^2=\Delta t^2-\beta_2\Delta t, \ \Delta^2t^3=\Delta t^3-\beta_3\Delta t, \ldots \Delta^2t^n=\Delta t^n-\beta_n\Delta t & \\
\gamma_3=\dfrac{\Sigma''\Delta^2t^3}{\Sigma''\Delta^2t^2}, \ldots\ldots\ldots\ldots \gamma_n=\dfrac{\Sigma''\Delta^2t^n}{\Sigma''\Delta^2t^2} & \\
\Delta^3t^3=\Delta^2t^3-\gamma_3\Delta^2t^2 \ldots \Delta^3t^n=\Delta^2t^n-\gamma_n\Delta^2t^2 & \\
\mathfrak{A}=\dfrac{\Sigma y}{s} \qquad y'=y-\mathfrak{A} & \\
\mathfrak{B}=\dfrac{\Sigma'y'}{\Sigma'\Delta t} \qquad y''=y'-\mathfrak{B}\Delta t & \\
\mathfrak{C}=\dfrac{\Sigma''y''}{\Sigma''\Delta^2t^2} \qquad y'''=y''-\mathfrak{C}\Delta^2t^2 & \\
\mathfrak{D}=\dfrac{\Sigma'''y'''}{\Sigma'''\Delta^3t^3} \qquad y^{\mathrm{iv}}=y'''-\mathfrak{D}\Delta^3t^3 &
\end{array}\right.$$

* For the complete analysis, which is quite simple, the reader is referred to the original lithographed memoir published in 1835, or to its republication in 1837 in Liouville's *Journal de Mathématiques*, tome ii, page 193. The same thing is also appended as a note to the first volume of Moigno's *Calcul Différentiel*, page 513; and a partial translation of it in the *U. S. Coast Survey Report* for 1860, p. 392.

Σ, Σ', &c., indicate the algebraic sum of the s values of the respective functions before which they are placed; but before taking the sum Σ', the signs of all the numbers corresponding to the cases in which the values of Δt are negative, and including these values themselves, must be changed. Similarly before taking Σ'', Σ''', &c., signs must be changed throughout for the cases in which $\Delta^2 t^2$, $\Delta^3 t^3$, &c., respectively are negative. So that $\Sigma'\Delta t$, $\Sigma''\Delta^2 t^2$, ... $\Sigma^{[m]}\Delta^m t^m$ are the absolute sums of these quantities. The following equations

$$(4) \qquad \Sigma^{[m]}\Delta^n t^p = 0, \quad \Sigma^{[m]} y^{[n]} = 0$$

are true for all values of n greater than m, and may therefore be used as *checks*. Each of the conditions (4) breaks up (except the case in which $n=1$) into two more convenient partial sums; for, denoting the sum of all the values of a function corresponding to positive values of $\Delta^m t^m$ by $\Sigma^{[m]}(+)$, and of those corresponding to negative ones by $\Sigma^{[m]}(-)$, the equation

$\Sigma = 0$ is equivalent to $\Sigma^{[m]}(+) + \Sigma^{[m]}(-) = 0$, and
$\Sigma^{[m]} = 0$ " " $\Sigma^{[m]}(+) - \Sigma^{[m]}(-) = 0$; whence

$$(5) \qquad \Sigma^{[m]}(+) = 0, \qquad \Sigma^{[m]}(-) = 0,$$

which may take the places of Σ and $\Sigma^{[m]}$ in the form (4). There might occur cases in which this principle of subdivision could be carried on still farther. The advantage of using (5) instead of (4) lies in the narrower limits within which it is necessary to look for an error discovered by means of (5).

The special forms of the various functions are written out in (3) as far as will suffice for determining four terms in the value of y, and computing y^{iv} so as to test the accuracy of the approximation and apply the checks (5) to it. An inspection of (3) will show:

1st, that the first term, $\mathfrak{A}$, is simply the *average value of* y.

2d, that to determine the second term it will be necessary to compute y', α_1, Δt, and $\mathfrak{B}$:

3d, for the third term, y'', α_2, Δt^2, β_2, $\Delta^2 t^2$, and $\mathfrak{C}$:

4th, for the fourth term, y''', α_3, Δt^3, β_3, $\Delta^2 t^3$, γ_3, $\Delta^3 t^3$, and $\mathfrak{D}$: and so on till the residual quantities, $y^{[m]}$, are seen to be small enough to be neglected.

If more special forms are desired besides those written out in (3), the law of their formation is obvious from an inspection of those actually developed there. It is such that, in general, if μ and $\mathfrak{M}$ be the mth letters in their respective alphabets, then

$$\mu_n = \frac{\Sigma^{[m-1]}\Delta^{m-1} t^n}{\Sigma^{[m-1]}\Delta^{m-1} t^{m-1}}, \qquad \Delta^m t^n = \Delta^{m-1} t^n - \mu_n \Delta^{m-1} t^{m-1}$$

$$\mathfrak{M} = \frac{\Sigma^{[m-1]} y^{[m-1]}}{\Sigma^{[m-1]}\Delta^{m-1} t^{m-1}}, \qquad y^{[m]} = y^{(m-1)} - \mathfrak{M}\Delta^{m-1} t^{m-1}.$$

It will be observed that no cases occur in which n is less than m.

To get out symmetrically the coëfficients of (1) it is easy to find that they are of the following forms:

$$(6)\quad \begin{cases} A=\mathfrak{A}+[1]\mathfrak{B}+[2]\mathfrak{C}+[3]\mathfrak{D}+\text{ &c.} \\ B=\quad\ \mathfrak{B}+[2']\mathfrak{C}+[3']\mathfrak{D}+\text{ &c.} \\ C=\quad\ \mathfrak{C}+[3'']\mathfrak{D}+\text{ &c.} \\ D=\quad\ \mathfrak{D}+\text{ &c.} \\ \quad\ \text{etc.}\quad\ \text{etc.}\quad\ \text{etc.} \end{cases}$$

in which

$$[1]=-\alpha_1$$
$$[2]=-\alpha_2-\beta_2[1] \qquad [2']=-\beta_2$$
$$[3]=-\alpha_3-\beta_3[1]-\gamma_3[2] \quad [3']=-\beta_3-\gamma_3[2'] \quad [3'']=-\gamma_3$$
$$\text{etc.} \qquad\qquad \text{etc.} \qquad\qquad \text{etc.}$$

EXAMPLE.

[Löwel's Solubility of Anhydrous $NaO\,SO_3$ in water, developed in powers of $t-50°$.—*Annales de Chimie et Physique*, xlix, 50.]

	y	t	t^2	t^3	y'	Δt	Δt^2	Δt^3
1.	5325	−32·00	1024·0	− 32768	+487·5	− 27·684	+ 400·9	− 39445
2.	5276	30·00	900·0	27000	438·5	25·684	276·9	33677
3.	5153	25·00	625·0	15625	315·5	20·684	+ 1·9	22302
4.	5131	24·00	576·0	13824	293·5	19·684	− 47·1	20501
5.	5037	20·00	400·0	8000	199·5	15·684	223·1	14677
6.	4971	17·00	289·0	4913	133·5	12·684	334·1	11590
7.	4953	16·00	256·0	4096	115·5	11·684	367·1	10773
8.	4878	9·85	97·0	956	+ 40·5	5·534	526·1	7633
9.	4781	− 4·96	24·6	− 122	− 56·5	− 0·644	598·5	6799
10.	4682	+ 0·40	0·2	0	155·5	+ 4·716	622·9	6677
11.	4542	9·79	95·8	+ 938	295·5	14·106	527·3	− 5739
12.	4435	20·61	424·8	8755	402·5	24·926	− 198·3	+ 2078
13.	4296	34·42	1184·7	40779	541·5	38·736	+ 561·6	34102
14.	4265	+53·17	2827·0	+150314	− 572·5	+ 57·486	+2203·9	+143687
Σ	67725	−60·42	8724·1	+ 93482	0	+ 0·004	+ 0·7	+ 4
Σ′					−3935·0	279·936	+2833·3	+334798

	y''	Δ^2t^2	Δ^2t^3	y'''	Δ^3t^3	y^{iv}	
1.	+ 98·4	+ 681·2	− 6335	+ 6·3	−18220	+ 8·3	$\alpha_1=-4·316$
2.	77·5	536·9	− 2959	+ 4·9	12326	+ 6·3	$\alpha_2=+623·1$
3.	24·8	211·3	+ 2436	− 3·8	− 1251	− 3·7	$\alpha_3=+6677$
4.	+ 16·8	+ 152·2	3041	3·8	+ 386	3·8	
5.	− 21·0	− 64·3	4081	12·3	5203	12·9	$\beta_2=+10·125$
6.	44·8	205·7	3580	17·0	7169	17·8	$\beta_3=+1196·0$
7.	48·7	248·8	+ 3201	−15·1	7542	−15·9	
8.	37·3	470·1	− 1014	+26·3	7188	+25·5	$\gamma_3=+17·447$
9.	65·6	592·0	6029	14·3	+ 4300	13·8	
10.	89·2	670·6	12317	+ 1·5	− 617	+ 1·6	$\mathfrak{A}=4837·5$
11.	97·2	670·1	22610	− 6·6	10916	− 5·4	
12.	− 52·1	− 450·7	27733	+ 8·8	19870	+11·0	$\mathfrak{B}=-14·057$
13.	+ 3·0	+ 169·4	− 12227	−19·9	−15182	−18·2	
14.	+235·5	+1621·9	+ 74884	+16·2	+46587	+11·0	$\mathfrak{C}=+0·1352$
Σ′(+)	0	− 0·1	− 3	0	+ 2	0	
Σ′(−)	+ 0·1	+ 0·7	+ 2	− ·2	− 9	− ·2	$\mathfrak{D}=+0·000111$
Σ″	+911·9	6745·2	+117681	−·1 −·1	−6 −1	−·1 −·1	
Σ‴				+17·4	156757	−·1 −·1	

	$\beta_2\Delta t$	$\beta_3\Delta t$	$\mathfrak{B}\Delta t$	$\gamma_3\Delta^3 t^2$	$\mathfrak{C}\Delta^2 t^2$	$\mathfrak{D}\Delta^3 t^3$	
1.	− 280·3	− 33110	+ 389·1	+ 11885	+ 92·1	− 2·0	[1] = + 4·316
2.	260·0	30718	361·0	9367	72·6	1·4	[2] = − 666·8
3.	209·4	24738	290·7	3687	28·6	− 0·1	[3] = − 206
4.	199·3	23542	276·7	+ 2655	+ 20·6	0·0	
5.	158·8	18758	220·5	− 1122	− 8·7	+ 0·6	[2′] = − 10·125
6.	128·4	15170	178·3	3589	27·8	0·8	[3′] = − 1019
7.	118·3	13974	164·2	4341	33·6	0·8	
8.	56·0	6619	77·8	8202	63·6	0·8	[3″] = − 17·4
9.	− 6·5	− 770	+ 9·1	10328	79·9	+ 0·5	
10.	+ 47·7	+ 5640	− 66·3	11700	90·7	− 0·1	A = 4686·6
11.	142·8	16871	198·3	11694	90·6	1·2	B = − 15·539
12.	252·4	29811	350·4	− 7863	− 60·9	2·2	C = + 0·1333
13.	392·2	46329	544·5	+ 2955	+ 22·9	− 1·7	D = + 0·000111
14.	+ 582·0	+ 68753	− 808·0	+ 28297	+ 219·3	+ 5·2	

In this example, to which Cauchy's method is applied, the numbers in the column y express the solubility* of anhydrous sulphate of soda in 10,000 parts of water at 14 different temperatures,—column t contains the corresponding temperatures *less* 50° (for convenience of development). The work is carried as far as the determination of four terms in the development according to powers of (temp. −50°); but a comparison of the values of y^{iv} with those of y''' shows that nothing is gained by the addition of the fourth term. Since the values of A, B, &c., are obtained by using (6) it is not necessary to obtain the coefficients a, b, &c., at all. In taking the sum Σ' the signs are to be changed in the first nine cases; therefore $\Sigma'(+)$ means the algebraic sum of the last five cases, and $\Sigma'(-)$ that of the first nine. $\Sigma''(+)$ is the algebraic sum of the 1st, 2d, 3d, 4th, 13th and 14th cases, and $\Sigma''(-)$ of the rest. $\Sigma'''(+)$ includes the 4th, 5th, 6th, 7th, 8th, 9th, and 14th, and $\Sigma'''(-)$ the rest. The values of $\Sigma''(+)$ and $\Sigma''(-)$ are written on the same horizontal line opposite the argument Σ''; similarly with $\Sigma'''(+)$ and $\Sigma'''(-)$ for y^{iv}.

M. Bienaymé has shown† that if each case of the equations,

$$\begin{aligned} y &= A + Bt + Ct^2 + \&c. \\ y' &= \quad B\Delta t + C\Delta t^2 + \&c. \\ y'' &= \quad\quad C\Delta^2 t^2 + D\Delta^2 t^3 + \&c. \\ &\text{etc.} \qquad\quad \text{etc.} \qquad\quad \text{etc.} \end{aligned}$$

were multiplied by the proper *least-square* factor (different for each case and for each of these equations) before taking the sums Σ, Σ', &c., the process would become merely another form for the expression of the elimination in *least-squares* given by Gauss‡ and others.

The advantages of Cauchy's method are its simplicity, the ease

* According to Löwel, *Annales de Chimie and Physique*, xlix, page 50.

† *Comptes Rendus*, tome xxxvii, 4 Juillet 1853; and Liouville's *Journal de Mathématiques*, xviii, page 299. See also Cauchy's Note, *Comptes Rendus*, xxxvi, 27 Juin, 1853.

‡ In the *Disquisitio de elementis Palladis;* and translated into French on page 137 of the *Méthode des Moindres Carrés*.

with which the important check (5) is applied to the work, and the fact, which is of great importance in many of its applications to physics, that it is not necessary to determine beforehand how many coefficients A, B, &c., are to be eliminated. The objections, which seem fatal to it as a substitute for *least squares* where the latter is properly applicable, are of very little importance in cases where the form of the function is wholly assumed and the formula therefore only to be trusted within the limits of the series of observations; for in these cases the formula which gives a minimum value to the sums of the squares of the differences between the computed and observed quantities, is not necessarily better than many others giving other sets of properly distributed small differences, especially as "the errors of observation" are frequently mixed up with others *of the same order of magnitude,* arising from errors in the values of the variables, t, t^2, &c.

If however the series of observations is very extensive (like those, for instance, on the tension of steam) the labor of finding an empirical formula becomes altogether greater than its value, and it is better to *tabulate* the function without reference to any "interpolation-formula" satisfying the whole or even any great number of the observations. For this purpose the observed quantities must first be reduced to equidistant values of the variable, and then these may easily be interpolated to as frequent intervals as we please by the methods in common use.

To accomplish the first object there are several methods. The mechanical one of *plotting a curve* (however valuable in suggesting *the true physical law* of the phenomena) cannot often be used for this purpose with as much accuracy as computation. In the method of interpolation by "*divided differences*"* each determined place depends only on a very few of the adjacent observations, and a series of such places, unless the observations were accurate to the last figure, would not be apt to harmonize. Another way is as follows: let one of the equidistant values of the variables be t_0, then the observations may be represented, *in the vicinity of* t_0, by the series,

$$(7) \qquad y=A+B(t-t_0)+C(t-t_0)^2+\&c.$$

in which A is obviously the required value of y corresponding to $t=t_0$, and may be determined in each case from as many observations as we please to use. Cauchy's *method* applied in this way to some of Regnault's observations has been found to give an accurate table of vapor-tensions with very little labor. Determinations of A were made for every 6° of temperature from 9° to 39°, and ten observations were used for each determination.

* See Lacroix, *Calcul*, tom. iii, p. 81, § 903; or De Morgan, *Calculus*, p. 550.

ART. IV.—*On Electrical currents circulating near the Earth's surface, and their connection with the phenomena of the Aurora Polaris.*—9th ARTICLE; by ELIAS LOOMIS, Professor of Natural Philosophy and Astronomy in Yale College.

IN vol. xxxii, pp. 324–335 of this Journal, I have shown the existence of a stream of electricity drifting across Central Europe in a direction from about N. 28° E. to S. 28° W. For several months I have been collecting the materials for a similar discussion in this country, and now present the results of these enquiries. My materials are derived from the magnetic observations made at Toronto, Cambridge and Philadelphia, from May 1840 to Dec. 1842, and during a portion of this time at Washington also. The observations at the first three stations were made with needles mounted in the manner recommended by Gauss; but those at Washington were made with a declination compass having a needle of eleven inches in length, whose motions were much less free than those of Gauss' construction, and which therefore did not give the time of the maxima and minima with equal precision. For this reason the last column in the following table contains a large number of blanks. The table exhibits a list of all those cases in which there was a well marked maximum or minimum value of the magnetic declination, and when this maximum or minimum value was of short duration. All the dates are expressed in the mean time of Göttingen.

OBSERVED DEFLECTIONS OF THE HORIZONTAL MAGNETIC NEEDLE.

			Toronto.		Cambridge.		Philadelphia.		Washington.	
			h.	m.	h.	m.	h.	m.	h.	m.
1840.	May 29.	Maximum,	10	55	10	55	10	55		
		Minimum,	11	10	11	5	11	10		
		Max.	11	35	11	25	11	30		
		Min.	11	40	11	30	11	35		
		Max.	11	50	11	35–40	11	45		
		Min.	12	0	11	50	11	55		
		Max.	12	15	12	5–10	12	15		
		Min.	12	35	12	30	12	35		
		Max.	13	45	13	40	13	45		
		Max.	14	15–20	14	15	14	15		
		Min.	15	0	15	0	15	0		
		Min.	15	50	15	45	15	50		
		Max.	15	55	15	55	15	55		
		Min.	16	25	16	10	16	20		
		Max.	16	35	16	35	16	35		
		Min.	16	45	16	45	16	45		
		Max.	17	0	16	55	17	0		
		Min.	17	15	17	5	17	10		
		Max.	17	25	17	15	17	20		
		Min.	17	35	17	30	17	30–35		
		Max.	18	5	18	0	18	5		
		Max.	20	35	20	30	20	30–35		

Table continued.

			Toronto.		Cambridge.		Philadelphia.		Washington.	
			h.	m.	h.	m.	h.	m.	h.	m.
1840.	May 30.	Max.	0	50–55	0	50	0	50		
		Min.	2	5	2	5	2	5		
		Max.	2	20	2	20	2	20		
		Max.	9	30	9	30	9	25		
		Min.	9	35	9	35	9	35		
	June 24.	Max.	16	40			16	35–40		
	June 25.	Min.	5	10			5	10		
	July 22.	Max.	16	25			16	25		
		Min.	19	0			19	0		
		Max.	19	20			19	20		
		Min.	19	40			19	40		
	July 23.	Max.	5	10			5	10		
	Aug. 28.	Max.	10	45–50	10	40–45	10	45		
		Min.	11	35	11	30–35	11	30–35		
		Max.	11	50	11	50	11	50		
		Min.	13	25	13	25	13	25		
		Max.	14	40	14	35–40	14	40		
		Min.	15	5	15	5	15	5		
		Max.	15	15	15	10	15	10		
		Min.	15	40	15	35	15	35		
		Min.	16	20–25	16	20	16	20		
		Max.	16	35	16	30	16	30		
		Min.	16	45–50	16	40	16	40–45		
		Max.	17	5	17	0	17	0–5		
		Min.	17	20	17	20	17	20		
		Max.	17	40	17	35	17	40		
		Min.	18	5	17	55	18	0		
		Max.	18	15	18	5	18	10		
		Min.	18	30	18	20	18	25		
		Max.	18	35	18	30	18	35		
		Min.	18	50	18	45	18	50		
		Max.	19	20	19	10	19	15		
		Max.	19	50	19	50	19	50		
		Max.	23	25	23	25	23	25		
	Sept. 23.	Max.	10	40	10	40	10	40	10	45
		Max.	13	50	13	40–50	13	50	13	55
		Min.	15	45–50	15	45	15	55	15	50
		Min.	22	50	22	50–55	22	50	22	50
	Sept. 24.	Min.	0	35	0	35	0	35	0	30
		Min.	2	15	2	15	2	15	2	15
		Max.	2	35	2	30	2	30–35	2	35
		Min.	4	30	4	30	4	30	4	35
	Oct. 21.	Max.	10	50	10	45	10	45	10	45–50
		Min.	11	10	11	5	11	5		
		Max.	14	50	14	50	14	50		
		Min.	15	15	15	10–15	15	15		
		Max.	16	0	16	0	16	0		
		Min.	16	35	16	25–30	16	30	16	35
	Oct. 22.	Min.	3	35	3	35	3	35		
	Nov. 28.	Max.	2	15	2	15	2	15	2	20
	Dec. 23.	Max.	11	45	11	45	11	45	11	45
		Max.	13	10	13	10	13	10	13	10
		Min.	13	25	13	25	13	25	13	25
		Max.	13	40	13	35	13	35	13	35
		Min.	14	20	14	15	14	15	14	15
		Max.	15	0	14	55	14	55–60	15	0
		Max.	15	20	15	20	15	20		
		Min.	18	50	18	50	18	50	18	50
		Max.	22	30	22	20	22	20–25	22	20–25

Table continued.

			Toronto.		Cambridge.		Philadelphia.		Washington.	
			h.	m.	h.	m.	h.	m.	h.	m.
1840.	Dec. 24.	Max.	1	30	1	30	1	30		
		Max.	2	55	2	55	2	55		
		Min.	3	5	3	5	3	5		
1841.	Jan. 20.	Max.	15	25	15	25	15	25		
	Jan. 21.	Min.	7	5	7	5	7	5	7	10
		Min.	8	50	8	50	8	50	8	50-55
	Feb. 26.	Max.	13	15	13	15	13	15	13	15
		Min.	13	50	13	40-50	13	50	13	50
		Max.	15	10-15	15	10	15	10	15	10
		Min.	15	35	15	30	15	30	15	30
		Max.	16	0-5	15	55-60	16	0	16	0
		Min.	21	30	21	30	21	30	21	30
	March 24.	Max.	12	5	12	0	12	5		
		Min.	12	20-25	12	20	12	20-25		
		Max.	12	40	12	40-45	12	40		
		Min.	15	25-30	15	25	15	25		
		Max.	15	45-50	15	45	15	45		
		Max.	16	25	16	20	16	25		
		Min.	18	25	18	25	18	25		
	April 21.	Max.	11	15	11	15	11	15	11	15
		Max.	14	50	14	50	14	50	14	45-50
		Max.	15	20	15	15	15	20		
		Min.	15	30	15	30	15	30		
		Max.	15	45	15	40	15	45		
		Min.	15	55	15	55	15	55	15	55-60
		Min.	18	20	18	20	18	20		
	May 28.	Max.	12	25	12	20	12	20-25	12	25
		Max.	13	45-50	13	45	13	45	13	50
		Min.	14	15	14	15	14	15	14	15
	June 23.	Max.	10	40	10	40	10	40	10	40
		Max.	12	10	12	10	12	10		
		Min.	19	10	19	5-10	19	10		
		Min.	23	15	23	10-15	23	15		
	June 24.	Max.	1	40	1	40	1	40		
		Min.	3	45	3	45	3	45		
	July 21.	Max.	14	35	14	30-35	14	30-35	14	35
		Min.	14	55	14	50	14	50	14	50
		Max.	15	25	15	20	15	25	15	25
		Min.	16	15	16	10	16	10-15	16	10-15
		Min.	17	45-50	17	45-50	17	50	17	50
		Min.	19	10-15	19	15	19	10-15	19	15
		Max.	20	0	19	55	20	0		
		Min.	21	15	21	15	21	15	21	15
	July 22.	Min.	3	40	3	40	3	40	3	35
	Aug. 27.	Min.	10	50	10	50	10	50	10	50
		Min.	12	55	12	50	12	50		
		Max.	13	15	13	15	13	15	13	15
		Max.	14	55	14	55	14	55	14	55
		Max.	17	30	17	25	17	25-30	17	30
		Min.	18	20	18	20	18	20	18	20
		Max.	19	30	19	25	19	30	19	30
	Aug. 28.	Max.	1	35	1	30-35	1	35	1	35
		Min.	7	40	7	35-40	7	40	7	40
	Sept. 22.	Max.	18	40	18	40	18	40		
	Sept. 23.	Min.	0	30	0	30	0	30	0	30
		Min.	3	10	3	10	3	10	3	10
	Oct. 20.	Max.	14	50	14	45	14	45	14	45-50
		Max.	18	45	18	40	18	45	18	45
		Min.	19	0	18	55	19	0	19	0
		Max.	19	10	19	5	19	5	19	5

Table continued.

			Toronto.		Cambridge.		Philadelphia.		Washington.	
			h.	m.	h.	m.	h.	m.	h.	m.
1841.	Oct. 20.	Min.	19	30	19	30	19	30		
		Max.	19	50–55	19	50	19	50	19	50–55
		Min.	22	5	22	5	22	5		
	Oct. 21.	Min.	0	5	0	5	0	5	0	5
		Max.	3	10	3	10	3	10	3	10
	Nov. 26.	Max.	14	40	14	35–45	14	30–40	14	40–45
	Dec. 22.	Min.	20	5	20	5	20	5	20	5
		Min.	22	15–20	22	15–20	22	15–20		
1842.	Jan. 19.	Max.	12	24	12	20	12	24		
		Max.	16	42	16	40	16	42		
		Min.	17	12–18	17	15	17	12–18		
	Feb. 25.	Min.	11	36	11	30	11	30		
		Max.	12	0–6	12	0	12	0–6	12	5–10
		Max.	15	0	15	0	15	0	15	0
		Min.	19	42–48	19	45	19	42–48	19	45
	Feb. 26.	Min.	0	0	0	0	0	0	0	0
	March 23.	Max.	13	0	13	0	13	0	13	0
		Min.	14	12	14	10	14	12	14	15
		Max.	17	12–18	17	15	17	18	17	15
	March 24.	Max.	4	0	4	0	4	0	4	0
		Min.	8	36	8	35–40	8	36	8	30–35
	April 20.	Max.	13	30	13	30	13	30	13	30
		Min.	14	0	14	0	13	54	14	0
		Min.	15	48	15	50	15	48–54	15	50
		Max.	16	24–30	16	20–25	16	24	16	25
		Max.	19	30	19	30	19	30	19	30
		Min.	19	48–54	19	55	19	54	19	55
	April 21.	Max.	6	0	6	0	6	0	6	0
	May 27.	Max.	14	54–60	14	55	14	54	15	0
		Max.	19	24–30	19	25–30	19	24–30	19	30
	June 22.	Min.	14	18–24	14	20	14	18	14	20
		Max.	15	6	14	55	15	6	15	5
		Max.	16	42	16	40–45	16	42	16	45
		Max.	17	18	17	15	17	18	17	20
		Max.	17	54–60	17	50	17	54	17	55
		Max.	19	36–48	19	30	19	36–42	19	45
		Max.	20	36	20	35	20	36	20	35
	June 23.	Max.	0	0	0	0	23	54–60	0	0
		Max.	8	36	8	35	8	36	8	40
	July 20.	Max.	13	18	13	15	13	18		
	Aug. 26.	Max.	11	48–54	11	45	11	48		
		Max.	14	18	14	10	14	12		
		Min.	14	30	14	25	14	30		
		Max.	15	36	15	30	15	30		
	Aug. 27.	Min.	4	0	3	55	3	54		
	Sept. 21.	Min.	12	54–60	12	55	12	54		
		Max.	13	30	13	20–25	13	24		
		Max.	17	54	17	45–50	17	48		
		Min.	19	24	19	15	19	18		
		Max.	21	54–60	21	55	21	54		
	Sept. 22.	Max.	4	0	3	55	3	54		
		Max.	8	12–18	8	10	8	12		
	Oct. 19.	Max.	13	30	13	25	13	24		
		Min.	18	0–6	18	0	18	0		
		Max.	21	24	21	25	21	24		
		Max.	22	24	22	25	22	24		
	Oct. 20.	Max.	0	30	0	30	0	30		
	Nov. 25.	Max.	15	18	15	15	15	18		
	Dec. 21.	Max.	14	48	14	45	14	48		
		Max.	17	48–54	17	45–50	17	48		

The following table shows in how many cases the maximum deviation of the magnetic needle occurred earlier at Cambridge, Philadelphia or Washington than it did at Toronto; in how many cases it occurred at the same instant; and in how many cases it occurred later than at Toronto. From May, 1840, to Dec. 1841, the observations at each station were made at intervals of 5 minutes; but in 1842 the observations at Toronto and Philadelphia were made at intervals of 6 minutes. The differences therefore in the times of maximum deviation are generally 0, or 5 or 10 minutes; but when at one of the stations the indications of the needle were sensibly the same at two successive observations, we may obtain differences of $2\frac{1}{2}$ or $7\frac{1}{2}$ minutes. In the few cases in which other differences are obtained, they have been classed with the numbers in the table to which they approached nearest.

Maximum deviation of the magnetic needle.

	Cambridge.	Philadelphia.	Washington.
$12\frac{1}{2}$ minutes earlier,	2		
10 " "	7		
$7\frac{1}{2}$ " "	6	1	1
5 " "	34	19	2
$2\frac{1}{2}$ " "	16	25	7
At the same instant,	44	70	28
$2\frac{1}{2}$ minutes later,	2	1	7
5 " "			5
Average result,	$3^m{\cdot}11$ earlier.	$1^m{\cdot}40$ earlier.	$0^m{\cdot}15$ later.

These observations indicate that the maximum deviation of the magnetic needle advances like a wave over the earth's surface; and that the direction of its motion is from N. 68° E. to S. 68° W. A comparison of the Cambridge and Toronto observations indicates a velocity of progress amounting to 113 miles per minute; while a comparison of the Philadelphia and Toronto observations indicates a velocity of only 75 miles per minute.

The following table shows in how many cases the minimum deviation of the magnetic needle occurred earlier than at Toronto; in how many cases it occurred at the same instant; and in how many cases it occurred later than at Toronto.

Minimum deviation of the magnetic needle.

	Cambridge.	Philadelphia.	Washington.
15 minutes earlier,	1		
10 " "	6		
$7\frac{1}{2}$ " "	2		
5 " "	17	18	5
$2\frac{1}{2}$ " "	12	8	2
At the same instant,	40	56	21
$2\frac{1}{2}$ minutes later,	4	3	7
5 " "	1	0	3
$7\frac{1}{2}$ " "		1	
Average result,	$2^m{\cdot}29$ earlier.	$1^m{\cdot}10$ earlier.	$0^m{\cdot}04$ later.

These observations indicate that the minimum deviation of the magnetic needle advances like a wave over the earth's surface; and that the direction of its motion is from N. 69° E. to S. 69° W. A comparison of the Cambridge and Toronto observations indicates a velocity of progress amounting to 156 miles per minute; while a comparison of the Philadelphia and Toronto observations indicates a velocity of only 103 miles per minute.

We thus see that the average progress of the maxima and minima deviations of the magnetic needle was very nearly in the same direction and with the same velocity. Assuming that the average direction of both classes of waves is the same, we find their progress to be from N. 68° E. to S. 68° W.; and the velocity of their progress deduced from a comparison of the Cambridge and Toronto observations is 134 miles per minute; while the velocity deduced from a comparison of the Philadelphia and Toronto observations is 89 miles per minute.

In my former article, p. 334, I found that in Central Europe, the deflections of the magnetic needle were propagated in a direction from N. 28° E. to S. 28° W. Mr. C. V. Walker determined that the direction of this motion in England was from N. 42° E. to S. 42° W.; and we now find this direction in the neighborhood of New York to be from N. 68° E. to S. 68° W.

At the time of a considerable number of the preceding observations, auroras were recorded at some one of the stations. The following are the auroral notices at Toronto, corresponding to some of the preceding dates. The dates are all given in the mean time of Göttingen.

Auroral observations at Toronto.

1840. May 29. 15^h. Faint light in north.
$15^h\ 16^m$, faint streamers shot up from N.E. to altitude 60°; a most brilliant aurora followed.
16^h, aurora most brilliant.
$16^h\ 5^m$, a perfect arch from N.W. to N.E. Splendid streamers rising from it, and almost a continued gleam of light from the incessant flashes or pulsations.
17^h. Streamers disappeared; faint patches of light and a few pulsations.
18^h. Very faint light arch, dark clouds rising in N. horizon.
19^h. Bright aurora.
20^h. Bright aurora.
Aug. 28. $14^h\ 30^m$. Splendid aurora.
15^h. Aurora visible at intervals.
$17^h\ 30^m$. Aurora very splendid.
18^h. Auroral light obscured by the clouds.
19^h. Overcast.
21^h. Cleared up; aurora again visible.

1840. Oct. 22. From 15^h to 18^h faint auroral light.
Dec. 23. 17^h. Bank of auroral light in N.; faint streamers.
18^h. Auroral light in N. Patches of light and streamers.
19^h. Faint auroral light in N.
1841. April 21. 15^h. Auroral light in N. horizon; a few faint streamers rising from it.
20^h. Faint auroral light to N.
July 21. $17^h\ 30^m$. Bright bank of auroral light in N.
19^h. Faint auroral light in N.
20^h. Faint auroral light in N.
21^h. Faint auroral light in N.
Oct. 20. $14^h\ 35^m$. Auroral light in N.
$15^h\ 20^m$. Very faint auroral light along N. horizon.

The following notices of the aurora were recorded at Washington. The dates are given in the mean time of the place.

Auroral observations at Washington.

1840. Aug. 28. From $8^h\ 30^m$ to $9^h\ 45^m$ P. M. the aurora distinctly visible, extending from N.E. by N. to N.W. by N.; faint appearances of it at irregular intervals, until $1^h\ 45^m$ A. M. of 29th.
Sept. 23. At $10^h\ 40^m$ P. M. a segment of an auroral arch, extending from N.N.E. to N.N.W.; centre or highest point, N. by E.; altitude 8°.

The following auroral notices are from the register kept at New Haven by Mr. E. C. Herrick.

Auroral observations at New Haven.

1840. May 29. A conspicuous aurora. A narrow belt overhead between 9^h and 10^h; and after 10^h auroral waves as high as zenith.
Aug. 28. A considerable aurora visible. An arch 40° high in N. between 10^h and 11^h. Few streamers.
Oct. 22. A distinct aurora. An arch 2° or 3° high lying 30° or 40° along the northern horizon.
Dec. 24. During most of the evening there seemed to be a faintly luminous vapor, particularly in the N., but also more or less elsewhere.
1841. March 24. An auroral arch low in N. horizon all evening; about 2° high; bright. I saw no streamers.
July 21. A faint auroral illumination at 10 P. M. and also at 2 A. M. of the 22d.
Oct. 21. About 1 A. M. a brilliant auroral display, not extending higher than 40°; streamers rapidly shifting.
1842. April 20. Slight aurora about 11^h, and faint traces through the night.

If now we make the comparison for those dates at which an aurora was recorded at Toronto, we shall find that the maxima and minima deviations of the magnetic needle occurred at Cam-

bridge on an average $3^{m}\cdot88$ earlier than at Toronto, and at Philadelphia $1^{m}\cdot87$ earlier than at Toronto. These results are a little greater than those obtained from a comparison of all the observations, and indicate a motion somewhat more nearly east and west; but the general character of the results is the same. We seem authorized then to infer that *in the eastern part of the United States the irregular deflections of the magnetic needle, whether attended or not by any auroral exhibition, are generally propagated in a direction from N. 68° E. to S. 68° W., and with an average velocity of about* 112 *miles per minute.*

During the exhibition of brilliant auroras, auroral beams do not ordinarily continue stationary for many minutes. They generally exhibit a movement of translation towards the south, and frequently also a movement to the east or west of the meridian. In order to determine whether there is any uniformity in the direction of this motion, I have collected together all the notices of this kind which I could find recorded in the Am. Journal of Science, in the Reports of the N. Y. Regents, and in various other works. The following is the result of this examination.

Notices of lateral displacement of the auroral beams.

From the American Journal of Science.

Vol. xiv, p. 92. 1827, Aug. 28. New York City. Waves of light began to flow from the eastern toward the western part of the luminous arch. The whole arch moved towards the south.

Vol. xiv, p. 94. Troy, N. Y. The flowing of the light from E. to W. was constant.

Vol. xiv, p. 104. Canandaigua, N. Y. About the time that the arch broke up into columns, it seemed to move back towards the north. Soon after it moved again to the south, apparently with a more rapid motion than ever.

Vol. xiv, p. 105. 1827, Sept. 9. Canandaigua, N. Y. A light cloud, moved gently to the west, and gradually put on the appearance of beams of light. Proceeding still west, and probably a little south, they seemed to lengthen and descend toward the western horizon. The movement westward was distinct, but not sufficiently so to enable me to estimate the rate of motion.

Vol. xiv, p. 106. Ib. The western motion of the fragments was perceptible, and was estimated at four degrees in thirty-two seconds.

Vol. xxvii, p. 113. 1833, May 17. Philadelphia, Pa. This arch passed gradually towards the south.

Vol. xxvii, p. 119. 1833, July 10. Philadelphia. Four beams were visible; the last beam vanishing after appearing to move westward.

Vol. xxix, p. 389. 1835, Nov. 17. New Haven, Conn. The zone moved slowly to the south, until about 9 o'clock. From this time it began to recede northward.

Vol. xxx, p. 135. 1835, Dec. 11. Toronto, Canada. All these rays moved in a very stately march from east to west.

Vol. xxx, p. 231. 1835, Sept. 4. New Haven, Conn. The streamers all moved to the east about 6°. Beams shot up about 30° high, and moved laterally to the east.

Vol. xxxii, p. 178. 1837, Jan. 25. New Haven. The twilight of the northern sky moved slowly southward.

Vol. xxxii, p. 221. 1836, Aug. 12. Ib. Over head the arch moved southward. In the east it also advanced southward.

Vol. xxxii, p. 222. Ib. Parallel fleeces, distinct from each other, were in slow motion toward the west.

Vol. xxxii, p. 225. 1836, May 8. New Haven. The arch advanced southward.—The bow moved slowly south.—The arch had advanced southward.

Vol. xxxii, p. 394. 1836, May 8. Toronto, Canada. A shining broad column of light passed very slowly and bodily to the westward.

Vol. xxxiii, p. 212. 1837, July 29. Burlington, Vt. A luminous arch moved slowly to the south.

Vol. xxxiv, p. 275. 1837, Nov. 14. Geneva, N. Y. A bright white streamer passed the north star, on its way to the west.

Vol. xxxviii, p. 262. 1839, Sept. 3. Nashville, Tenn. A westward motion was observed in three principal columns.

Vol. xxxviii, p. 376. 1839, Sept. 3. Middlebury, Vt. The belt moved south—rapidly at first, then more slowly.

Vol. xxxix, p. 194. 1840, May 29. New Haven. The belt drifted southward at the rate of about a degree per minute.

Vol. iii, n. s., p. 440. 1847, April 7. New Haven. The auroral belt moved southward from 77° above the N. horizon to 65° above the southern.

Vol. xiii, n. s., p. 427. 1852, Feb. 19. New Haven. Streamers began to shoot upward, having a horizontal movement from E. to W.

Vol. xiv, n. s., p. 131. 1852, April 22. New Haven. The whole beam slowly moved southward.

Vol. xxviii, n. s., p. 391. 1859, Aug. 28. New Haven. Auroral arch advanced 18° toward the south in fifteen minutes.

Vol. xxviii, p. 394. 1859, Aug. 28. West Point, N. Y. A yellowish cloud advanced southward with an even boundary.

Vol. xxviii, p. 394. Ib. The streamers in the north were numerous and were perceived universally to move towards the west.

Vol. xxviii, p. 395. Ib. The entire expanse of cloud in the south was making a similar progress west, at the rate of forty degrees in about two minutes. At 3 A. M. the streamers in the north moved across the constellation Cassiopea from west to east, contrariwise to the motion in every instance I have before observed in any aurora.

Vol. xxviii, p. 396. Ib. The southern streamers were also moving to the east.

Vol. xxviii, p. 404. 1859, Sept. 2. Havana, Cuba. The summit of the arch had a movement of translation toward the east. A brightness streamed from the north, moving towards the N.N.E.

Vol. xxviii, p. 406, Ib. Reiterated movement of translation of the whole aurora from E. to W., followed by a retrocession in the opposite direction.

Vol. xxix, p. 252. 1859, Aug. 28. Halifax, N. S. The streamers appeared to work from W. by N. to south. I think they worked along from E. to W., but another observer said from W. to E.

Vol. xxix, p. 257. 1859, Aug. 28. Steubenville, Ohio. At 7½ P. M. the aurora moved to the south. At 9 P. M. the light advanced again and passed clear to the south as before.

Vol. xxix, p. 258. 1859, Aug. 28. Burlington, N. J. An arch of light rose in the north, passed the zenith, and descended to within about 20° of the south horizon.

Vol. xxix, p. 260. 1859, Aug. 28. Sacramento, Cal. Lambent streamers were noticed to shift gradually from west to east and vice versa.

Vol. xxix, p. 263. 1859, Aug. 28. Galveston, Texas. Stately columns of light reaching up about 45° from the horizon, moved westward about one degree for every ninety seconds of time.—The columns drifted westward and faded.

Vol. xxx, p. 86. 1859, Aug. 28. Cleveland, Ohio. Bright rays suddenly shot up in quick successive flashes, reaching nearly to the zenith, and moving slowly to west.

Vol. xxx, p. 87. 1859, Sept. 1. Fort Bridger, Utah Ter. The light appeared to flow gradually from N.N.E. to the southern sky.

Vol. xxx, p. 345. 1859, Aug. 28. Gettysburgh, Penn. The streamers were visibly wafted round on the east and west to the S.E., S.W., and even south.

From New York Meteorology 1826–1850, *by Franklin B. Hough.*

Page 487. 1827, Aug. 28. Lowville, N. Y. The arc began to move in a southern direction....it broke up into parallel pieces which moved majestically westward.....At 11 its motion was mainly south.

Page 487. 1827, Aug. 28. Pompey, N. Y. The arc gradually inclined towards the south.

Page 488. 1830, July 15. Fredonia, N. Y. A belt at right angles with the galaxy, moved towards the south.

Page 489. 1831, April 1. Albany, N. Y. Shot up into brilliant columns moving eastward.

Page 489. 1831, April 19. Utica, N. Y. A beautiful arc, elevated about 50°, gradually rose, passed the zenith, and descended into the south within 25° of the horizon.

Page 489. 1831, June 21. Albany, N. Y. Shot up into brilliant prismatic columns which moved from W. to E., preserving in their motion a parallel position. In one or two instances, a sudden and rapid motion in the opposite direction towards the west.

Page 489. 1831, July 3. Albany, N. Y. Shot up into columns which appeared to move slowly in some cases to the east.

Page 490. 1831, July 31. Johnstown, N. Y. An arch moved south about 20°.

Page 490. 1833, May 17. Johnstown, N. Y. Parallel columns of light moved rapidly from N. to S.

Page 491. 1835, Sept. 9. Albany, N. Y. A faint white arch in the northern hemisphere which moved towards and passed the zenith.

Page 491. 1836, April 12. Cazenovia, N. Y. A single beam from the horizon moved sensibly to the south.

Page 493. 1837, Nov. 14. Buffalo, N. Y. Red streams further east appeared moving slowly eastward.

Page 493. 1837, Nov. 14. St. Lawrence, N. Y. Tall columns of silvery light were seen in the northern horizon, sometimes shooting up to the zenith, and again moving slowly from E. to W. as if impelled by a gentle breeze.

Page 496. 1842, June 4. Rochester, N. Y. A fine arc rose N. of E. and moved southward.....Grew fainter, moved slowly southwards, extended down to the horizon, began to move in slow portions to the west.

Page 497. 1847, March 19. North Salem, N. Y. Streamers ascended to the height of 20°; all of which had a slow motion to the eastward.

Page 497. 1847, March 19. Woodstock, Vt. Pillars moving sometimes eastward and then westward, and sometimes rapidly passing each other.

Page 498. 1847, Nov. 25. North Salem, N. Y. A few streamers rose to the height of 45°, having a slow motion westward.

Page 498. 1848, April 1. Rochester, N. Y. Luminous white pillars; white pencils in the N.E. gradually passing westward and vanishing west of north.

Page 498. 1848, April 6. New York City. Streamers shooting up and moving westward.

Page 499. 1849, March 18. North Salem, N. Y. Streamers shot up: at first generally white; occasionally a tinge of red. The whole had a slow motion to the west.

From Arago's Meteorological Essays.

Page 448. 1827, Aug. 27. New York. A great number of bright streamers, which underwent a very rapid horizontal or lateral movement from east to west.

Page 449. 1827, Aug. 28. New York. There were in the north two concentric arches. The upper arch rose gradually higher above the horizon; reached the zenith; passed beyond it and then broke up. Vertical columns of light, having rather a rapid movement of translation, carrying them from E. to W., showed themselves below the great arch.

From newspaper records.

1835, Nov. 18. Hanover, N. H. Very brilliant streamers appeared to chase each other, running rapidly from W. to E. and back again from E. to W.

1839, Sept. 3. Middlebury, Vt. The auroral belt moved south, rapidly at first, then more slowly. Five parallel streamers, about 3° long, moved to the west, but not so rapidly as to be directly seen in motion.

1839, Sept. 14. Middlebury, Vt. There were seen in the arch prismatic streamers in active motion. Some of the motions were from west to east.

1841, Nov. 18. New Haven, Conn. There were two zones in the north, and columns slowly moving eastward.

From the Record of Auroral Phenomena by Peter Force.

Page 37. 1821, April 27. Fort Enterprise, lat. 64½°, long. 113° W. A single column of aurora rose in the north, and traversed the zenith towards the south. It passed to the western horizon in ten minutes.

Page 42. 1820, Dec. 4. Ib. A broad arch passed gradually to the southward.....A bright arch had a direction from N. to S.....A well formed arch moved slowly to the southward.

Page 44. 1820, Dec. 11. Ib. The arches moved slowly to the southward.

Page 62. 1850, Jan. 1. Fort Franklin, lat. 65°, long. 123° W. The aurora changed its position, progressing regularly and gradually towards the south.

Page 102. 1820, Feb. 10. Winter Harbor, lat. 74½°, long. 110° W. A low arch to the westward, from which pencils appeared to proceed. These pencils had a slow, though very sensible, lateral motion from north to south and vice versa.

The preceding catalogue includes 36 cases in which the motion of auroral arches and beams was described as from N. to S., and only three cases of a motion from S. to N. In the aurora of Aug. 28, 1827, at Canandaigua, N. Y., the arch seemed to move back towards the north; and soon after it moved again to the south more rapidly than ever. In the aurora of Nov. 17, 1835, at New Haven, the auroral zone, after moving for some time toward the south, began to recede northward; and also in the aurora of Feb. 10, 1820, at Winter Harbor, the auroral pencils had a slow lateral motion from N. to S. and vice versa.

We may hence conclude that in the United States, great auroras almost invariably exhibit a motion from N. to S. with occasionally and temporarily a slight retrograde movement from S. to N.

The preceding catalogue includes 31 cases in which the motion of auroral beams was described as from E. to W.; and 15 cases of a motion from W. to E. If auroral streamers had a motion exactly from N. to S. then those streamers which were included between the N. and E. points of the horizon would have an apparent motion towards the E.; while those streamers which were included between the N. and W. points of the horizon would have an apparent motion towards the west. It seems probable that the apparent motion from E. to W. and from W. to E. is frequently due to an actual motion from N. to S.; but since the apparent motion towards the W. is twice as frequent as that towards the E. we must conclude that *the actual motion of the streamers is from about N.N.E. to S.S.W.*

We thus find a general correspondence between the direction of the electric currents which traverse the earth's surface during displays of the aurora, and the motion of the auroral beams. In the United States, the former move from about N. 68° E. to S. 68° W., while the latter move from about N. 30° E. to S. 30° W.

ART. V.—*Observations on the Saltwaters of the Alleghany and Keskeminetas Valleys;* by Dr. EDWARD STIEREN.

I. *Preliminary remarks.*

WITHIN a distance of about 35 miles above the city of Pittsburgh there have been bored, on both sides of the Alleghany and Keskeminetas rivers, more than thirty saltwells, the greater part of which are used for the manufacture of common salt.

These valleys belong to the coal period and the strata have a gentle dip to the southwest. There is no rock-salt, and no deposits of gypsum have ever been found in this district.

In boring these wells we pass through sandy shale, fire-clay, limestones, and different kinds of marl and clay-slates, through porous, white and red sandstone in strata of various thickness, and several veins of bituminous coal, from two to seven feet in thickness. One of these sandstones is from 70 to 100 feet in thickness, and is usually found at a depth of from 200 to 250 feet; this rock contains small quantities of carbonate of lime, baryta and strontia.

These mineral waters are, we believe, formed by the percolation of meteoric waters through the superincumbent beds of marls and clays, from which, assisted by the carbonic acid received from the atmosphere, and by pressure, they dissolve saline matters till an impenetrable stratum is reached, where they remain, saturating the porous sandstone and filling the fissures of the surrounding beds.

The wells are from 400 to 1200 feet deep, and from 3 to 3½ inches in diameter, and are lined with copper pipes.

An examination of many of the brines of the Alleghany and Keskeminetas valleys during a series of years past has convinced me that, as respects their chemical constituents, they are among the most interesting cold saline mineral waters, which have as yet been analyzed. Several of these wells yield, besides salt water, a very superior quality of petroleum, which has been introduced into commerce, and for many years used for medical, illuminating, and lubricating purposes. They also give off an inflammable gas.

These brines are qualitatively all alike, but not in the quantities of their constituents. Their specific gravities are from 1·0175 to 1·098, that is from 2½ to 13 degrees of Beaumé's hydrometer.

The brines of all the saltworks of both valleys, are without exception pumped by steam power. A yellowish colored sediment, which by degrees becomes red, is deposited in the spouts, in which the brine is carried from the pump to the boiling pan,

but in the boiler itself a much larger quantity of the yellow-reddish sediment is precipitated, which becomes when exposed to the air for a few days, of a deep red color. The natural brine when boiled down to a specific gravity equal to from 1·124 to 1·160, (=16 to 20° B.) is then drawn off into a wooden cistern, where it is mixed with a thin lime-milk, and well stirred. After clearing, this brine is drawn off or pumped into the grainers where after the well known process the salt is obtained either fine or coarse. Both pans are heated by the same fire and so placed that the grainer is behind the boiler. Bituminous coal is exclusively used as fuel.

During a period of four years I have analyzed quantitatively brine from several wells of the Alleghany and Keskeminetas Valleys, but I shall here give only the analysis of water which was obtained from the salina of Mr. Peterson, in the vicinity of Tarentum.

II. *Physical properties.*

When freshly pumped this saltwater appears turbid, owing to petroleum which is suspended in it, though after standing a little while it becomes clear and the petroleum floats on the surface, forming a scum, thicker or thinner, according to the proportion of petroleum which is contained in the brine, which is of a reddish-yellow color. Its taste is saline, afterwards bitter, and it smells slightly of petroleum. The average specific gravity, from my experiments, is found to be equal to 1·0352, at +18·5° C. The temperature of the water is equal to 17·5° C., at 20° temperature of the atmosphere. If exposed to the air, the water by degrees becomes turbid from loss of gas (CO^2) and deposits a dirty yellow-colored precipitate, on the sides and bottom of the beaker-glass, changing after a few days to a reddish-yellow color, a change hastened by boiling.

III. *Chemical properties.*

A. *Qualitative Analysis.*

The solid constituents of this water are divided into two classes, like those of almost all other brines.

1. Such as are of themselves insoluble in water, and which are kept in solution by the free carbonic acid.
2. Such as are soluble in water.

a. *Properties of the fresh water.*

1. Blue and red paper, and fresh prepared tincture of litmus, are not in the least changed.
2. Strips of paper moistened with a solution of acetate of lead were not at the least changed to a blackish or gray color, but became covered with a pure white powder.
3. Basic nitrate of bismuth suspended in the water retained its pure white color.

4. When the gas obtained by boiling the water is conducted into a solution of sugar of lead, acidulated with acetic acid, no change of color, and no precipitate is produced in the lead solution.

5. The gas obtained by boiling the water reddened litmus paper instantly, but not permanently. The same gas conducted into limewater caused a strong turbidness, and afterwards produced a precipitate which, while effervescing, was perfectly soluble in muriatic acid.

6. The addition of acids produced a slight escape of air bubbles.

7. Sulphuric acid produced a strong turbidness and quickly caused a precipitate which when repeatedly boiled with water was resoluble, leaving a very small quantity of a white sediment. This sediment proved to be baryta when treated before the flame of the blowpipe, and particularly when some chlorate of potash was added; the changing color of the flame satisfied me that the sediment also contained strontia.

8. Lime-water made the brine turbid, but by adding an excess of the latter the mixture became clear again.

9. Sesquichlorid of iron produced a red-brown tint.

10. Caustic ammonia produced a dirty white precipitate, which was partly soluble in a solution of salammoniac.

11. The carbonates of potassa and ammonia produced permanent whitish precipitates.

12. Chlorid of barium produced a strong turbidness, which by adding diluted nitric acid disappeared, air bubbles being expelled.

13. Oxalate of ammonia produced a copious white precipitate.

14. In the liquid filtered from the precipitate of 13 a crystalline precipitate was formed by the addition of caustic ammonia and phosphate of soda.

15. Nitrate of silver produced a copious, white, caseous precipitate, soluble in caustic ammonia, and giving an opalescent liquid. Nitric acid had but a very slight effect upon the precipitate.

16. Gallic acid produced, after some standing, a violet tint.

17. Tannic acid produced, after some standing, a reddish-violet tint.

18. Ferrocyanate of potassa produced, after standing, a slight bluish tint.

19. Sesquiferrocyanate of potassa produced, after standing, a greenish tint.

20. Hydrosulphuret of ammonia produced, after standing, a greenish tint.

21. When some of the brine was slightly acidulated by muriatic acid, and some of the reagents mentioned under 16 to 20 added to it, then the different tints were produced instantly. In No. 20 was formed, after a few hours, a blackish precipitate, in voluminous flocks.

22. A solution of gypsum produced in the brine, when slightly acidulated with nitric acid, a marked turbidness, which after a few hours settled into a precipitate. This precipitate, when washed with water and dried, and treated before the flame of the blowpipe, showed to be a mixture of strontia and baryta.

23. The chlorids of platinum and gold, had not the slightest effect on the fresh brine.

24. Chlorid of palladium produced in the brine, after the latter had been slightly acidulated with nitric acid and after standing for a short

time, a brown turbidness, which soon settled to the bottom in form of flakes of a blackish color.

25. Molybdate of ammonia had no effect upon the brine, either in the cold nor by boiling it, after being acidulated with nitric acid.

26. Chlorid of lime produced a brown turbidness, and after standing a good while longer, a voluminous precipitate of the same color.

27. When the brine was mixed with strong chlorine-water and a little carbonate of soda, a white turbidness was produced, which by heating increased, turning to a yellow color.

b. *Properties of the brine after heating.*

About 40 pounds of the fresh brine were put into a large porcelain dish and brought cautiously and by degrees nearly to the boiling point and evaporated, until salt crystals made their appearance, besides the reddish-yellow powder obtained soon after the commencement of the evaporation. The sediment together with the liquid was put upon a filter, and the first was edulcorated with pure water, and then dried. The filtered solution was marked *a a*, and the dried precipitate *b b*.

a. a. *The solution, or the filtrate* a. a. *was subjected to the following experiments.*

1. Reaction perfectly neutral.

2. Caustic ammonia produced a voluminous and perfectly white precipitate, entirely soluble in a solution of salammoniac.

3. Carbonate of potassa produced a perfectly white precipitate, which increased when the mixture was boiled.

4. Chlorid of barium produced no change.

5. Oxalate of ammonia produced a copious white precipitate.

6. By adding to the liquid, filtered from the precipitate of No. 5, caustic ammonia and phosphate of soda, and then stirring it well, a crystalline white precipitate was obtained.

7. Nitrate of silver produced a white precipitate with a slight yellowish tint. This precipitate when mixed with nitric acid and well stirred and filtered, and submitted to a slow and very careful neutralization with caustic ammonia, no yellow precipitate could be produced.

8. Gallic and tannic acid, ferrocyanate and sesquiferrocyanate of potassa, and hydrosulphuret of ammonia, did not change the solution in the least.

9. Some of the liquid by evaporation was more concentrated and after cooling mixed with an alcoholic solution of platinum-chlorid, by which a yellow precipitate was obtained. To prevent errors, a second portion of the liquid, of which the alkaline earths were precipitated by carbonate of soda, the mixture evaporated almost to dryness, then again treated with water, filtered, and the solution so obtained concentrated again by a slow evaporation. By adding to this solution a small quantity of a spirituous solution of chlorid of platinum, a lemon-colored precipitate was also produced, which consisted of a combination of chlorid of potassium and of platinum, together with a combination of chlorid of ammonium and of platinum.

10. Another part of the filtrate was evaporated almost to dryness, and by heating it in a test tube, with a concentrated solution of caustic po-

tassa, a gas was expelled which turned curcuma paper brown, and which formed white vapors when a glass-rod moistened with muriatic acid was brought in contact with the gas. The same was also the case when the brine was acidulated with muriatic acid and evaporated to dryness, and then treated exactly as before mentioned.

11. A solution of gypsum produced a strong turbidness which soon settled as a precipitate, this was entirely insoluble in nitric acid. The precipitate well edulcorated was treated with carbonate of potassa and melted in a silver crucible, then the melted mass soaked in water. The insoluble matter was collected upon a filter and well washed, then dissolved in muriatic acid; the solution obtained evaporated to dryness, and the dry salt treated with alcohol, in which a portion of it was dissolved. The spirituous solution contained chlorid of strontium, and the parts insoluble in alcohol consisted of chlorid of barium.

12. A portion of the filtrate was slightly evaporated, and the crystallized chlorid of sodium was separated from the concentrated liquid. This solution when shaken in a bottle with chlorine-water, became of an intense brownish-red color. By the treatment with ether this mixture became colorless, while the ether itself was colored.

When by a cautious evaporation of a somewhat larger quantity of the filtrate (a. a.) the chlorid of sodium was separated as much as possible and the concentrated liquid evaporated until completely dry, again dissolved in water, and the solution exsiccated in a temperature of from 120 to 130° C., and after this operation had been repeated eight times, then not the slightest trace of bromine could be detected.

13. One part of the solution (a. a.) was shaken with some fresh boiled starch, and some drops of nitric acid added, which turned the mixture instantly to a deep dark blue color.

14. Another part of the solution was boiled with phosphate of silver; the liquid filtered from the chlorid of silver formed was evaporated to dryness. This dry salt was put in a test-tube, and some sulphuric acid added, and strongly heated in the alcohol flame, but no yellow-colored vapor escaped here, which would have colored yellow the stripes of paper saturated with solution of indigo, when brought in contact with them.

In another experiment some of the liquid was acidulated with concentrated sulphuric acid, and mixed with a saturated solution of sulphate of protoxyd of iron; but no darker tint of the mixture was produced.—Absence of nitric acid.

15. Some of the solution was acidulated with muriatic acid, and then evaporated slightly. Curcuma-paper dipped into the liquid was not browned by it, but kept its natural color.—Absence of boracic acid.

16. To a part of the solution was added caustic potash-liquor in a slight excess, then heated and filtered. When a solution of salammoniac was added to the filtered liquid neither turbidness nor a precipitate was produced.—Absence of alumina.

17. In order to determine if the (boiled) brine contains *lithium*, a sufficient quantity of carbonate of soda was added to the remaining and larger quantity of the solution *a. a.* and then boiled. After the precipitated alkaline earths had been edulcorated with water, the filtered liquid was evaporated to dryness and the residue gently heated. In treating

this heated substance with water a turbid solution was obtained, which, after filtering, appeared clear and colorless; the contents of the filter consisted of magnesia. As caustic soda in the *cold*, and carbonate of soda *by boiling*, did not produce the slightest changes in the filtered solution, phosphate of soda was added to the bulk of the liquid and then evaporated to dryness. This exsiccated salt mass was soaked in water, in which it was dissolved, leaving only a very small quantity of light white powder. After the powder had settled in a high glass cylinder, and the cleared solution was removed, the powder was collected upon a filter, and well washed with water. The dried light powder was heated with perfectly pure carbonate of lime, the heated mass then several times boiled with water, filtered, and the contents of the filter washed. The lime of this alkaline-reacting solution was precipitated by oxalic acid. The oxalate of lime was well edulcorated, and the solution obtained evaporated to dryness and then heated, in order to decompose the oxalates. After heating, the remaining mass was soaked in water, and treated with muriatic acid, when some coal remained, which was removed by filtration. The colorless liquid evaporated to dryness left a small quantity of a whitish substance, which was put in a bottle with a glass stopper, and absolute alcohol poured upon it; the alcohol acted upon the substance for several hours, during which time the bottle was often shaken. One part of the filtered alcoholic solution was evaporated, by adding some water to it, and then redissolved. The solution obtained produced no action upon caustic soda and oxalate of ammonia, but by adding phosphate of soda and heating it in a test-tube a white turbidness was instantly produced. The other part of the alcoholic solution inflamed, burnt with a red flame.

These experiments seem to prove the presence of *lithion* in the salt water, in the shape of chlorid of lithium.

b. b. *Examination of the dried precipitate* (b. b.) *insoluble in water.*

1. This precipitate or sediment formed a reddish-yellow powder which had neither smell nor taste. By heating in a platina crucible its reddish-yellow color changed into a dark cinnamon brown, without carbonizing or giving any smell resembling that of burning organic substances, or changing moistened curcuma-paper into brown or reddening litmus-paper when brought near the mouth of the crucible. Some of the heated refuse, soaked in water, gave a solution which showed a strong alkaline reaction.

2. One part of the heated powder was put in a small glass retort, and a sufficient quantity of concentrated sulphuric acid gradually poured upon the same, the mixture was boiled for a while, and the vapors conducted by an adopter into water. It was observed that neither corrosion of the glass was perceptible, nor was any flake of silica to be seen in the water, not even after the solution was mixed with some ammonia and left standing for several days. The same was the case with the sediment which was separated from a sufficient quantity of brine by boiling, and which had not been washed with water. It was also used in the dry state, but was not heated. In neither of the experiments could fluorine be detected.

3. The rest of the dried precipitate (*b. b.*) was treated with muriatic acid in excess, in which it was dissolved, all but a small quantity of insoluble substance; the unfiltered solution was then evaporated to dryness and soaked in water adding to the liquid obtained some drops of nitric acid. The solution was filtered from the separated silica, which contained some alumina; the solution obtained was tried with reagents.

Caustic ammonia produced a dirty white precipitate.

Alkaline carbonate produced a permanent dirty white precipitate.

Chlorid of barium produced no change.

Oxalate of ammonia produced instantly a white precipitate.

To the liquid filtered from the precipitate last obtained caustic ammonia and phosphate of soda were added; by stirring this mixture with a glass rod, a crystalline precipitate was soon produced. Caustic potassa produced a dirty white precipitate, which partly disappeared by heating; by adding a solution of salammoniac to the filtered liquid, light white flakes were separated. A large part of the solution was mixed with a solution of gypsum, which produced a strong turbidness, which settling to a precipitate became by degrees clear. This precipitate collected upon a filter was well washed with water and dried, then melted in a silver crucible with carbonate of potassa, then soaked in water and washed upon a filter until a solution of chlorid of barium did not produce any change of the liquid which came from the filter. By treating the contents of the filter with diluted muriatic acid, and by adding some fluosilicic acid to the solution, the characteristic crystals of *baryta* were produced. The solution from which the crystals were obtained was evaporated to dryness. In testing the dry mass by the blowpipe the presence of *strontia* was easily and surely detected by the purple-red tint of the flame.

Sulphocyanid of potassium colored the liquid red.

Ferrocyanate of potassa produced a deep dark blue tint, and soon after a precipitate of the same color.

A clear filtered, concentrated solution of chlorid of lime, of the strength of 36 p. c. produced a small quantity of voluminous brown flakes.

Molybdate of ammmonia did not produce the slightest change in color.—Absence of phosphoric acid.

The greater part of the solution (*b b*, 3.) was subjected to an examination in order to ascertain if the brine contained a combination of *lithion* which would be insoluble in water, but all experiments proved that such was not the case.

The presence of *lithium* was indicated in experiment *a a*, 12; if not deceptive, seemed to render it probable that it might be found in larger quantities as chlorid of lithium in the mother-lye of our Salinas.

Several experiments were therefore made on a larger scale with the mother-lye, in order if possible to arrive at an approximate result for the natural brine.

Three pounds of mother-lye, (from Peterson's works,) of a specific gravity = 1·335, were mixed with a sufficient quantity of dried carbonate of soda, and evaporated; the desiccated mass heated, redissolved in water and filtered, aud then treated according to *a a*, 17. This experiment was repeated six times with the greatest care and exactness.

By evaporating the last filtrate of each experiment a very small quantity of a residuum was obtained each time.

Caustic potash and oxalate of ammonia caused no changes whatever in the solution; but phosphate of soda produced by heating a strong white turbidness.

The very small quantity of the dry white substance, from the evaporating dish of five of those larger trials treated by the blowpipe flame, did not contain the smallest quantity of *lithium*.

The change produced by phosphate of soda proceeded from traces of magnesia; and the red tint which was observed in the alcohol-flame (*a a*, 17) must therefore have been deceptive.

[An examination of the mother-liquor from the Salinas by means of the Spectroscope in the Sheffield Laboratory failed to detect the least traces of the new metals caesium and rubidium.—*Eds.*]

The preceding preliminary trials show the saltwater to contain:—

Potassa,	Lime,	Chlorine,
Soda,	Magnesia,	Bromine,
Ammonia,	Alumina,	Iodine,
Baryta,	Protoxyd of iron,	Carbonic acid,
Strontia,	Protoxyd of manganese,	Silicic acid.

Sulphuric, nitric, phosphoric and boracic acid, organic substances, fluorine, and sulphur, are absent from the brine.

In reference to the bromine contained in the brine, it may be observed that it is combined with magnesium, as the experiment (*a a*, 12) proved satisfactory. And in the examination of iodine, I combine it with calcium.

A perfectly neutral iodid of calcium gives a clear and colorless aqueous solution; the same is the case with the iodid of magnesium.

The iodid of calcium is partly decomposed at a temperature of from 120 to 160° C. The refuse, of course, shows an alkaline reaction; if the turbid liquid is filtered, the solution evaporated, and the inspissated mass heated in a crucible, then the decomposition continued at a temperature increased by degrees from 150 to 160° C. expelling iodine, leaving the lime in the crucible, which still contains some iodine. By repeating this operation six or seven times, the combination of iodine and calcium can be entirely discharged.

The iodid of magnesium treated in the same manner is also decomposed, like the iodid of calcium, but the complete decomposition of the combination of magnesium takes place at a much lower temperature, and even in the 3d and 4th operation.

B. *Results of the quantitive analysis.*

1. *Total quantity of the solid constituents.*

From 113·40 grammes of brine 5·5 grammes solid matter was obtained, dried at 100° C. temperature = 4·85 per cent, that is,

in 1000 parts.	in one pound = 7650 grains.
48·50.	372·48 grains.

2. *The separate constituents of the saltwater accounted by themselves.*

	In 1000 parts.	In one pound = 7680 grains, are grains:
Chlorine,	27·077266	207·953404
Bromine,	0·098992	0·760258
Iodine,	0·069176	0·531271
Carbonic acid,	3·929016	30·174843
Silicic acid,	0·125000	0·960000
Sodium,	13·059202	100·294672
Potassium,	0·021290	0·163507
Ammonium,	0·002184	0·016773
Baryta,	0·007447	0·057192
Strontia,	0·104094	0·799442
Lime,	5·832120	44·790683
Magnesia,	1·570055	12·058022
Alumina,	0·018270	0·140313
Protoxyd of iron,	0·023928	0·183767
Protoxyd of manganese,	*traces.*	*traces.*
	51·938040	398·884147

3. *Statement of the constituents, in the state as contained in the brine.*

	In 1000 parts.	In one pound = 7680 grains, are grains:
Chlorine,	27·077266	207·953404
Bromine,	0·098992	0·760258
Iodine,	0·069176	0·531271
Carbonic acid,	3·929016	30·174843
Silicic acid,	0·125000	0·960000
Sodium,	13·059202	100·294672
Potassium,	0·021290	0·163507
Ammonium,	0·002184	0·016773
Baryta (as such),	0·002948	0·022640
(Baryta as) barium,	0·004036	0·030996
Strontia (as such),	0·041493	0·318666
(Strontia as) strontium,	0·053005	0·407078
Lime (as such),	1·549614	11·901035
(Lime as) calcium,	3·117665	23·943667
Magnesia (as such),	0·655495	5·034201
(Magnesia as) magnesium,	0·564284	4·333701
Alumina,	0·018270	0·140313
Protoxyd of iron,	0·023928	0·183767
Protoxyd of manganese,	*traces.*	*traces.*
	50·412864	387·170795

4. *Statement of the combinations which these constituents, mentioned in No. 2 and 3, might form in the saltwater.*

	In 1000 parts.	In one pound = 7680 grains, are grains:
Chlorid of sodium,	32·977783	253·269374
" potassium,	0·040702	0·312592
" ammonium,	0·006709	0·051525
" barium,	0·006121	0·047009
" strontium,	0·095876	0·736327
" calcium,	8·578099	65·879800
" magnesium,	2·166399	16·637945
Bromid of magnesium,	0·115014	0·873307
Iodid of calcium,	0·080397	0·617448
Carbonate of baryta,	0·003784	0·029062
" strontia,	0·059276	0·455239
" lime,	2·763699	21·225208
" magnesia,	1·376540	10·571828
" iron,	0·038419	0·295057
" manganese,	*traces.*	*traces.*
Silicate of alumina,	0·040830	0·313575
Free silicic acid,	0·102440	0·786739
	48·452088	372·112036
Carbonic acid, loosely bound,	1·952889	14·998187
" " really free,	0·007887	0·060572
	50·412864	387·170795

5. *If the carbonates are accounted as bicarbonates, as they are contained in the salt water, then the proportions will be as follows:*

	In 1000 parts.	In one pound = 7680 grains, are grains:
Chlorid of sodium,	32·977783	253·269374
" potassium,	0·040702	0·312592
" ammonium,	0·006709	0·051525
" barium,	0·006121	0·047009
" strontium,	0·095876	0·736227
" calcium,	8·578099	65·879800
" magnesium,	2·166399	16·637945
Bromid of magnesium,	0·115014	0·873307
Iodid of calcium,	0·080397	0·617448
Bicarbonate of baryta,	0·004632	0·035574
" strontia,	0·077015	0·591475
" lime,	3·971630	30·502119
" magnesia,	2·088071	16·036385
" iron,	0·053259	0·409029
" manganese,	*traces.*	*traces.*
Silicate of alumina,	0·040830	0·313575
Free silicic acid,	0·102440	0·786739
	50·404977	387·110223
Carbonic acid, really free,	0·007887	0·060572
	50·412864	387·170795

6. 1000 *parts of salt water gave* 48·5 *parts of solid matters. But at* 4 *sub B. there are counted by the analysis only* 48·452088*; which is a loss of* 0·047912*, and it is possible, that, when the solid matters were weighed, they had not been perfectly dried. But by distributing this loss upon the single combinations, then we will have the following proportions:*

	In 1000 parts.	In one pound = 7680 grains, are grains:
Chlorid of sodium,	33·010394	253·519827
" potassium,	0·040748	0·312945
" ammonium,	0·006715	0·051571
" barium,	0·006127	0·047055
" strontium,	0·095970	0·736949
" calcium,	8·586581	65·944942
" magnesium,	2·168541	16·654496
Bromid of magnesium,	0·115127	0·884175
Iodid of calcium,	0·080476	0·618055
Carbonate of baryta,	0·003787	0·029084
" strontia,	0·059334	0·455685
" lime,	2·766431	21·246190
" magnesia,	1·377901	10·582281
" iron,	0·038457	0·295349
" manganese,	*traces.*	*traces.*
Silicate of alumina,	0·040870	0·313881
Free silicic acid,	0·102541	0·787515
Solid matters,	48·500000	372·480000
Carbonic acid, loosely bound, as bicarbonate,	1·952889	14·998187
" " really free,	0·007887	0·060572
	50·460776	387·538759

The large quantity of compounds of bromine and iodine contained in the brines of the Alleghany and Keskeminetas valleys, which are greater than in any other saltwater hitherto subjected to analysis, of which the results are known, together with their other constituents, recommend them strongly for use as baths in various diseases of the skin, in rheumatic-arthritic diseases, in certain pains of the abdominal and nervous system, in amenorrhœa and menstruatio suppressa, as a preparatory course to the use of iron baths. They have been found particularly useful in glandular diseases, and various forms of scrofula.

For therapeutic purposes baths of the crude brine may be used with advantage, as well as the mother-lye; the latter of course contains the combination of bromine and iodine in a much more concentrated form, and when used should be diluted as may be required by the addition of brine or fresh water.

I would pointedly call the attention of the medical profession to the powerful medical effect of these saltwaters, the more so, as within my own experience persons afflicted with the most in-

veterate scrofulous affections have been radically cured by using baths of the brine and mother-lye under my direction.

In conclusion I may remark that the inflammable gas alluded to consists essentially of 'marsh gas' (C_2H_4), with some carbonic acid and traces of oxygen and nitrogen.

No olefiant gas (C_4H_4) could be detected.

Tarentum, Alleghany county, Penn., March, 1862.

ART. VI.—*A Sketch of the Mandan Indians, with some Observations illustrating the Grammatical Structure of their Language;* by Dr. F. V. HAYDEN.*

THE Indians of the Missouri valley are divided into the nomadic and stationary tribes. The first class includes by far the greater number, who live mostly by the results of the chase, occupying skin tents and moving about from place to place, as their caprice or physical wants may dictate. Of the latter class, the Minnetarees, Arickaras, and Mandans are the best examples.

The Minnetarees or Gros Ventrees, as they are called by the Canadian Voyageurs, reside in a village of dirt lodges, near Fort Berthold, in lat. 47° 30′, lon. 102°. The village is surrounded by a rude stockade formed of cotton-wood logs, about fifteen feet in height, placed in the earth in an upright position. These Indians raise corn, beans, pumpkins, &c., to a considerable extent, even more than they need for their own support. They now number from 600 to 800 souls, but are decreasing slowly from disease and other causes.

The Arickaras or Rees occupy a village near Fort Clarke, lat. 47° 10′, lon. 101°, very similar to that of the Minnetarees. They also cultivate the bottom lands along the Missouri quite successfully, and in this way add largely to their means of comfort and support. The number of people comprising this tribe at the present time is about 650, men, women and children.

The Mandans or Mi-akh-ta-nīs, "people on the bank" (of the river), as they call themselves, must have resided on the banks of the Missouri at a very remote period, perhaps not near their present residence, but in several places along the river. It is also probable that if they migrated at all, they came from a southern direction, as the sites of different villages of very ancient date are seen along the Missouri, as low down as the present boundary between the United States and the Dakota country. Some of these antique ruins are said to have been Arickara vil-

* This Sketch is taken in part from a Memoir by the author entitled "Contributions to the Ethnography and Philology of the Indian Tribes of the Missouri Valley," now in course of publication by the American Philosophical Society, Philadelphia.

lages, which is doubtless the case. The observations thus far made, point to the conclusion that all these stationary tribes migrated in the same direction, from southeast to northwest along this river, which may be inferred from the circumstance that no remains of their villages are to be seen along any other stream than the Missouri.

Prior to the visit of Lewis and Clarke in the autumn of 1804, we possessed very little information of a reliable character in regard to the origin and early history of the Mandans. Col. D. D. Mitchell, in a letter addressed to Mr. H. R. Schoolcraft, and published in the 3d part of the "History of the Indian Tribes," refers to an early writer by the name of Macintosh, who it seems was connected with a French Trading Company as early as 1772. From his own account he left Montreal in the summer of 1773, crossing over the intervening country, reached the Mandan Villages on Christmas day. He says that at that time the Mandans occupied nine large towns, situated very near each other, and that at short notice they could muster 15,000 warriors. This is doubtless a great exaggeration, but that they were a formidable nation the ruins of numerous villages, along both sides of the Missouri, bear ample testimony.

The following extracts from the well-known work, "Travels of Lewis and Clarke to the Source of the Missouri," show very clearly the condition of the Mandans and other stationary tribes in 1804.

"The villages near which we are established are five in number, and are the residence of three distinct nations; the Mandans, the Ahnahaways, and the Minnetarees. The history of the Mandans, as we received it from our interpreters and from the chiefs themselves, and as it is attested by existing monuments, illustrates, more than that of any other nation, the unsteady movements and the tottering fortunes of the American nations. Within the recollection of living witnesses, the Mandans were settled forty years ago in nine villages, the ruins of which we passed about eighty miles below, and situated seven on the west and two on the east side of the Missouri. The two finding themselves wasting away before the small pox and the Sioux, united into one village, and moved up the river opposite to the Ricaras. The same causes reduced the remaining seven to five villages, till at length they emigrated in a body to the Ricara nation, where they formed themselves into two villages, and joined those of their countrymen who had gone before them. In their new residence they were still insecure, and at length the three villages ascended the Missouri to their present position. The two who had emigrated together still settled in the two villages on the northwest side of the Missouri, while the single village took a position on the southeast side. In this situation they were found by those who visited them in 1796; since which the two villages have united into one. They are now in two villages, one on the southeast of the Missouri, the other on the opposite side, and at the distance of three miles across. The first, in an open plain, contains about forty or fifty lodges, built in the same way as those of the Ricaras; the

second, the same number, and both may raise about three hundred and fifty men.

"On the same side of the river, and at the distance of four miles from the lower Mandan village, is another called Mahaha. It is situated on a high plain at the mouth of Knife-river, and is the residence of the Ahnahaways. This nation, whose name indicates that they were "people whose village is on a hill," formerly resided on the Missouri, about thirty miles below where they now live. The Assiniboins and Sioux forced them to a spot five miles higher, where the greatest part of them were put to death, and the rest emigrated to their present situation, in order to obtain an asylum near the Minnetarees. They are called by the French Soulier Noir, or Shoe Indians; by the Mandans, Wattasoons, and their whole force is about fifty men.

"On the south side of the same Knife-river, half a mile above the Mahaha, and in the same open plain with it, is a village of Minnetarees, surnamed Metahartay, who are about one hundred and fifty men in number. On the opposite side of Knife-river, and one and a half miles above this village, is a second of Minnetarees, who may be considered as the proper Minnetaree nation. It is situated in a beautiful low plain, and contains four hundred and fifty warriors. * * * * * * *

"The inhabitants of these five villages, all of which are within the distance of six miles, live in harmony with each other. The Ahnahaways understand in part the language of the Minnetarees; the dialect of the Mandans differs widely from both; but their long residence together has insensibly blended their manners, and occasioned some approximation in language, particularly as to objects of daily occurrence and obvious to the senses."

At the present time the Mandans occupy a small village about three miles above Fort Clarke, on the right bank of the Missouri, and do not number over 250 or 300 souls. The Ahnahaways mentioned by Lewis and Clarke were undoubtedly a portion of the Mandan nation, but I cannot discover any trace of their existence at this time. In 1833, when the Prince Neu Wied made his visit to the Upper Missouri, he remarks that the two Mandan villages were located the one about 300 paces above Fort Clarke, and the other about three miles higher up, on the same side of the river. It is evident that the former is now occupied by the Arickaras, while the latter is in possession of the small remnant of the Mandan nation now living. At the period above mentioned (1833) the first village was composed of 65 huts, with about 150 warriors, and the latter 38 huts with 83 warriors, both villages perhaps possessing 900 to 1000 souls.

Our knowledge of this nation obtained from the American Fur Company, commences in the year 1829, when, through that company, the Fur-trade on the Upper Missouri was established on a more solid basis than it had been by the French traders. Anterior to the above date, the latter had been trading with these Indians in their usual way, by building wintering houses,

putting therein a trader and a few men, with a small supply of goods, and abandoning the post in the spring, taking with them down the river their returns of furs and skins. The Arickaras at this time were residing in their village near Grand river, the ruins of which are still visible. In 1829 Fort Clarke was erected for the express purpose of trading with the Mandans and Minnetarees. The former tribe then possessed a population of about 1800 persons, and the latter about half that number.

It is somewhat remarkable that notwithstanding all the misfortunes that have overtaken the Mandans for so many years, they even to this time preserve their independence and individuality as a nation. Nearly all the Mandans speak the Minnitaree language, and many of them are familiar with the Dakota and Arickara tongues, but very few, if any, of the surrounding tribes have acquired that of the Mandans. But one white man has ever learned to speak the language fluently and he resided among them upwards of twenty years. I cannot ascertain that there are any peculiar difficulties in the pronunciation or structure of the language which should prevent individuals of other nations from acquiring it readily; indeed I think that the evidence is quite clear, as suggested by Mr. Gallatin, that it is remotely allied to the Dakota stock and presents few, if any more obstacles to its acquisition than the other dialects of that group.

In the year 1833 the Mandans were in their most prosperous state, well armed, good hunters, good warriors, with herds of buffalo within sight of their village—large cornfields and a trading post from which they could at all times obtain needed supplies. In their personal appearance prior to the ravages of small-pox, they were not surpassed by any nation in the Northwest. The men were tall and well made, with regular features and a mild expression of countenance not usually seen among Indians. Their complexion also was a shade lighter than that of other tribes, often approaching very near to that of some European nations. Another peculiarity, which has often been observed by travellers, was that some of them had fair hair, and gray or blue eyes, which are very rarely met with among other tribes. A majority of the women, particularly the young, were quite handsome, with fair complexions and modest in their deportment. They were also noted for their virtue. This was regarded as an honorable and most valuable quality amongst the young women, and each year a ceremony was performed in the presence of the whole village, at which time all females who had preserved their virginity, came forward, struck a post, and challenged the world to say ought derogatory of their character. As this was a religious ceremony, any persons present, who could with truth contradict the statement, felt bound to do so, and if

detected in a false statement, the female lost her standing forever afterward among the young of both sexes. In ordeals of this kind it was remarked that more than two thirds of the Mandan females came off victorious which is regarded as a great proportion, when the early training and the influences that surround them are taken into consideration. The fact that a ceremony of this kind exists among savages, tending to promote virtue and discourage vice, is, of itself, sufficient evidence of their mental as well as moral superiority.

Much more might be said in regard to the habits and characteristics of this tribe, which is one of the most interesting in the West, but we prefer to occupy the space allotted in some illustrations of the grammatical structure of their language. At this time the Mandans cultivate the soil and hunt buffalo when these animals are near their homes. The destructive influences of the small-pox which has, at different times, raged fearfully among them, have never crushed their indomitable spirit of pride and independence. They will not join with other nations near whom they reside, neither will they connect themselves with them by marriage, nor allow or practice any customs but those of their ancestors. Their religious rites are preserved entire, and the system of self-inflicting tortures is practiced at the present day. Being too few in number to form war-parties against neighboring tribes, they remain at home and defend themselves. The Dakotas frequently attack them, at or near their village, and in almost every engagement some Mandans are killed. In these skirmishes they exhibit an entire recklessness and contempt of death, which leads to acts of individual daring, generally fatal, though feared and respected by the surrounding tribes. Owing to this fact and the periodical visitation of some contagious disease, they are on the decrease, and will doubtless before many years become extinct, or fall a prey to some superior force of Dakotas at an unguarded moment.

Their principal chiefs are now dead, but in former times they held a most beneficent sway over this tribe. Their rule was seldom interrupted by claims or pretensions of other aspirants to public notice. They were respected for their judgment, and loved for the patriarchal care they felt in the general welfare, not feared on account of their personal bravery or extensive relationship as is the case with migratory bands. Old age also in both sexes was held in veneration, made comfortable and not neglected, as is the case with many of the savage tribes. They deposit their dead on scaffolds near their village and in warm weather their decomposition has a tendency to render the atmosphere unhealthy and engender disease, but no persuasion can induce them to bury in the ground according to the custom of the whites.

From the above brief sketch of the Mandans, the inference is

plain, that, although they possess all the characteristics of the North American Indians, they present a somewhat peculiar and superior type of the race. The notion that at one time prevailed, that they were of Welch origin, has long since been exploded and it is hardly necessary to allude to it in this connection. Although remotely connected, we think there is sufficient ground for the inference that the Mandan language is a dialect of the Dakota stock. This was the opinion of Mr. Gallatin although he was unable to make the proper comparisons. These I shall endeavor to make in detail at some future time. In the summer of 1855 I made a few observations in regard to the grammatical structure of this language, an abstract of which may be of some interest to those who are curious in such matters.*

I. Nouns.

1. With few exceptions, Mandan nouns have both a singular and plural form, as is shown by their termination: as, a-pe, *a leaf*, a-pīsh, *leaves;* ma-he, *a weed*, ma-hōsh, *weeds;* si, *a feather*, si-īsh, *feathers.*

2. The gender of nouns is indicated by the use of different words to express the sex: as, nu-mán-ke, *a man;* mi-he, *a woman;* hé-ro-ke, *a bull*, ptīn-de, *a cow*, ní-ka, *a calf.*

3. The case of a noun is known by its position in a sentence.

II. Adjectives.

4. Adjectives always follow the nouns which they describe: as, mi-he-shi-na-shūsh, *a handsome woman;* nat-kaṇ-ka-sīsh, *a hard heart.*

5. The numeral adjectives of the cardinal kind are as follows:

1, máh-a-na.	13, a-ga-ná-me-ni.
2, nū′m-pa.	14, a-ga-tō′p.
3, ná-me-ni.	15, a-ga-hū′ṇ.
4, tó-pe.	16, a-ki-ma.
5, kéh-ūṇ.	17, a-kú-pa.
6, ki-ma.	18, ak-tí-tuk-e.
7, ku-pa.	19, a-ga-máh-pe.
8, té-tuk-e.	20, nū′m-pa-pí-rah.
9, mah-pe.	21, nū′m-pa-pí-ra-ka-ro-máh-a-na.
10, pi-rah.	30, ná-me-ni-am-pí-ra-kōsh.
11, a-ga-máh-a-na.	40, tó-pa-pí-ra-kōsh.
12, a-ga-nū′m-pa.	50, keh-ūṇ-am-pí-ra-kōsh.

* In the "Contributions" a plan of orthography has been adopted, corresponding as closely as possible with the one prepared by the late Prof. W. W. Turner for the Smithsonian Institution.

All the vowels have the continental sound, as *a* in father, *e* in face, *i* in marine, *o* in go, note, *u* like *oo* in food. When a vowel terminates a syllable it is long, but if a consonant is added, the vowel is short. Exceptions to this remark are indicated as follows: *ŏ* as in got, or *ō* long, as in note when followed by a consonant. *G* has always the hard sound as in go, *h* when preceded by a vowel has the guttural sound of *ch* in the Scottish loch or Arabic ghain, *n* is sounded as in the French word *bon*. The above remarks are all that are needed for the pronunciation of the Mandan language.

60, kí-ma-am-pí-ra-kōsh.
70, kú-pa-am-pí ra-kōsh.
80, te-tuk-e-am-pí-ra-kōsh.
90, máh-pe-am-pí-ra-kōsh.
100, i-sū'k-máh-a-na.
1000, i-sú-ki-ka-kú-hi.
100,000, i-sú-ki-ka-kú-hi-i-sū'h-máh-a-na.
ná-ka-máh-a-na, *first one*, or *first time*.
i-ká-ha-sha-máh-a-na, *last one*, or *last time*.

III. Adverbs.

6. The following are some of the principal adverbs: tash-hák-tōsh, *perhaps;* hó-ra-ke-ku-sér-o, *day before yesterday;* mat-khé-o-más to, *day after to-morrow;* tēn-hásh, *afar off*.

IV. Prepositions.

7. Prepositions follow the nouns they govern: as, péh-ti, *by*, mi-péh-ti-nák-ta, *sit by me;* mun-i-kū'sh-ta, *through the water;* ti-rō'k-ta, *in the house*.

V. Conjunctions.

8. kén-i and ek-tē'k, *and;* kén-i-é-pīsh, *and I said;* kén-i-wa-ki-wá-wa-rūsh, *and I told him*.

VII. Pronouns.

9. Pronouns are simple or fragmentary. The fragmentary pronouns are used in the declension of nouns and adjectives and in the conjugation of verbs. The following may be regarded as an example of the intensive form of the simple pronoun.

mí-o-na, *I, myself*, or *I am*.
ní-o-na, *thou, thyself*, &c.
i-o-na, *he, himself*, &c.
nú-o-na, *we, ourselves*, &c.
ni-á-o-na, *you, yourselves*, &c.
i-á-o-na, *they, themselves*, &c.

The form of the fragmentary pronouns is shown in the following declensions of nouns and adjectives.

mi-hū'n-de, *my mother*.
ni-hū'nde, *thy mother*.
i-hū'n-de, *his mother*.

mōṇs, *my wife*.
nōṇs, *thy wife*.
kōṇs, *his wife*.
mōṇ-kér-ish, *my wives*.
nōṇ-kér-ish, *thy wives*.
kōṇ-kér-ish, *his wives*.

mín-i-ke, *my son*.
nín-i-ke, *thy son*.
i-kó-ni-ke, *his son*.
min-i-kōsh, *my sons*.
nin-i-kōsh, *thy sons*.
i-ko-ni-kōsh, *his sons*.

ma-shīsh, *I am good*.
ni-shīsh, *thou art good*.
iṇ-shīsh, *he is good*.
nu-shīsh, *we are good*.
ni-a-shīsh, *you are good*.
i-a-shīsh, *they are good*.

Verbs.

The following examples show the changes in the form of the verbs.

i-wa-seh-osh, *I do* or *perform anything*.
i-da-seh-osh, *thou*, &c.
i-i-seh-osh, *he*, &c.
nu-i-seh-ōsh, *we*, &c.
ni-i-seh-ōsh, *you*, &c.
i-a-i-seh-ōsh, *they*, &c.
nu-nōmp-sha-seh-ōsh, *we both do*, &c.
i-wa-seh-tōsh, *I*, &c.
ni-de-seh-tōsh, *thou*, &c.
i-seh-tōsh, *he*, &c.

nu-i-seh-tōsh, *we*, &c.
ni-a-seh-tōsh, *you*, &c.
i-o-na-seh-tōsh, *they*, &c.

wa-wa-ka-pu-sōsh, } *I paint or write,*
wa-ka-pu-sōsh, } or *am painting.*
tha-ka-pu-sōsh, *thou*, &c.
iṇ-ka-pu-sōsh, *he*, &c.

wa-ka-pūs-tōsh, *I will paint* or *write.*
ma-ka-pūs-tōsh, *thou*, &c.
iṇ-ka-pūs-tōsh, *he*, &c.
nu-ka-pūs-tōsh, *we*, &c.
ni-a-tha-ka-pūs-tōsh, *you*, &c.

ni-a-he-seh-ta (imperative), *do it all of you.*
i-sek-ta (imp.), *do.*

nu-ka-pu-sōsh, *we*, &c.
ni-a-pu-sōsh, *you*, &c.
i-a-pu-sōsh, *they*, &c.
nu-nōmp-sha-pu-sōsh, *we both*, &c.
i-a-ka-pūs-tōsh, *they*, &c.
wa-ka-pu-se, *a painting or writing.*
ka-pūs-ta, (imp.) *write.*
a-he-ka-pūs.ta, (imp.) *write, all of you.*

IMPERSONAL VERBS.

kap-kēsh, *it snows.*
kap-ke-kōsh, *it will snow.*
kap-ke-a-maṇ-ka-hōsh, *it is snowing all the while.*
ra-she-de-hūsh, *it thaws or melts.*
ra-she-dēh-tūsh, *it will thaw or melt.*

ktaṇ-hōsh, *it freezes.*
ktan-tōsh, *it will freeze.*
ra-pa-na-rūsh, *it hails.*
ra-pa-nak-tūsh, *it will hail.*
he-i-ni-hūsh, *it thunders.*

The most reliable account of the manners and customs of the Mandans which has ever been published may be found in a magnificently illustrated work entitled "Reise des Prinsen Maximilian zu Wied. 2 vols. 4to." The Prince of Neu Wied resided one winter with this tribe, and obtained his information under the most favorable circumstances, and therefore I regard it as entitled to great confidence. In the same work may be found an extended vocabulary—the only one ever published of this language, of any great value for philological purposes—with some interesting grammatical observations. The great flexibility of the Indian languages, and the extent to which combinations may be made, have induced some authors to complicate greatly the declension of the nouns and adjectives and the conjugation of the verbs. Sometimes the moods and tenses of verbs are multiplied to an almost indefinite extent, and the six cases of the Latin given to the substantives. I do not dispute the accuracy of any author on this subject; but simply say that I have not yet been able to find a grammatical system so complete in any of the Indian languages of the Northwest. So far as I can ascertain there are three moods to the verbs, indicative, imperative, and infinitive; three tenses, past, present, and future; and I cannot find that the simple form of the verb expresses more. Other tenses are formed by the union of different words. More thorough investigations hereafter will decide this matter.

The following examples are taken from the Prince Neu Wied's great work, in which he has treated of a number of the Indian languages of the Northwest. The orthography is slightly changed to adapt it to the system which I have adopted in my Me-

moir. To one unacquainted with the native languages of this country, it would seem hardly possible to find a grammatical structure so complicated and still so complete and systematic, yet perhaps there is no cultivated tongue among the civilized nations of the world more regular than that of the Chippewa and its cognate dialects. In the Dakota there are three numbers, singular, dual, and plural. In the Eskimo, according to Bäer, nouns have six cases, the same as Latin nouns, and three numbers, through all of which they are inflected. In the Yakama, one of the numerous dialects on the Pacific coast, as given by Father Pandosy, nouns and adjectives possess the six cases mentioned above, but only two numbers, the singular and plural, and the verb is conjugated with greater minuteness of detail. We can thus see that a careful study of our own aboriginal languages becomes a subject of the highest interest and importance to every professed philologist.

DECLENSIONS OF NOUNS.

Sing.	*Sing.*
nú-maṇ-ka, *the man.*	wo-ra-e-rú-pa, *the bow.*
nu maṇk-á-da, *of the man.*	wo-ra-e rú-pa-da, *of the bow.*
O-nu-maṇk, *to the man.*	wo-ra-e-rú-pa-á-ta, *to the bow.*
nú-maṇ-ka, *the man.*	wo-ra-e-rú pa, *the bow.*
nu-máṇk, *O man.*	wo-ra-e-rú-pa, *O the bow.*
nú-maṇ ka, *with the man.*	wo-ra-e-rú-pa-ta, *with the bow.*
Plur.	*Plur.*
nu-maṇ-ká-ra, *the men.*	wo-ra-e rú-pa-ke-rēsh, *the bows.*
O-nu-maṇ-ka, *of the men.*	wo-ra-e-rú-pa-ka-ra-tá, *of the bows.*
nu-maṇ-ka-ra-ta, *to the men.*	we-pa-e-rú-pa-ka-ra-a-tá, *to the bows.*
nu-maṇ-ka-ra, *the men.*	O-wo-ra-e-rú-pa-ke-rē′sh, *the bows.*
nu-man-ká-ke, *O the men.*	wo-ra-e-rú-pa-ke-rē′sh, *O the bows.*
wanting.	wo-ra-e-rú-pa-ka-ra-tá, *with the bows.*

Remarks in regard to Adjectives.

The adjective follows the noun which it qualifies or describes: as, miní′s-, shó-ta, *the white horse*, or *horse-white*, nu-mamk-, há-ra-ka, *the bold man*, pa-san-, psīsh, *swift-river*.

The comparative degree of adjectives is formed by the addition of the word o-páh-a-dēsh, "more," and the superlative by the addition of the word mí-kāsh, "most," as, shīsh, *good*, shi-, o-pah-a-dēsh, *better*, shi-, mi-kāsh, *best*; kā′sh-ka, *great*, násh-ka-, o-pah-a-dēsh, *greater*, kásh-ka-, mi-kash, *greatest*. ath-, hā′sh-kāsh, *this is great*. ath-, shīsh, *this is good*.

The verbs also are conjugated with remarkable regularity. A few forms only are given: wa-wa-ru-tōsh, *I eat* or *am eating*; wa-ra-ru-tōsh, *thou eatest* or *art eating*; i-wa-ru-tōsh, *he eats* or *is eating*; wa-nu-ru-tōsh, *we eat* or *are eating*; i-wa-ru-toh-e-dēsh, *you eat* or *are eating*; ro-wa-ru-ta-maṇ-ka-hūsh, *they eat* or *are eating*; wa-wa-rūt-ma-kih-hāsh, *I have eaten*; wa-wa-rūk-tōsh, *I shall* or *will eat*; i-u-a-ha-ra-pōsh, *I would have eaten*; wa-rūs-tá, *eat* (imperative); wá-ru-te-nis-tá, *eaten*; wa-rú-ta-máṇ-ka-hūsh, *eating*.

The preceding examples, of which many more might be given,

will serve to convey to the reader an idea of the strength and fullness of our aboriginal languages. Many of them seem to possess even greater flexibility than those of the cultivated nations of Europe. My own experience is confirmed by that of one of the most intelligent missionaries of the West, Rev. Wm. Hamilton, who has spent the greater portion of his life among the Iowas, and speaks their language with great fluency. In the preface to his excellent and elaborate grammar of the Iowa tongue he remarks that "the barrenness which is supposed to belong to most Indian languages, does not result from the structure or nature of the language, but from the want of ideas in those who use it. So far as *they have ideas*, they do not lack *words* to express them, though the mode of expression, among them, is often as different from that in use among us, as their language is from ours."

Smithsonian Institution, Washington, D. C., May 20th, 1862.

ART. VII.—*On Triethylamine;* by M. CAREY LEA, Philadelphia.

THE triethylamine which served for the following examinations was obtained, by the action of nitrate of ethyl upon ammonia, making the alkaloids thus obtained react upon fresh portions of the compound ether. The following was the course of the operation.

Three volumes of nitrate of ethyl with three volumes of liquid ammonia, thoroughly saturated with ammoniacal gas and two volumes of absolute or nearly absolute alcohol, were sealed up in glass tubes and were kept in boiling water for four hours. The tubes were then opened, the contents neutralized with nitric acid, and evaporated over a chlorid of calcium bath. When freed as far as possible from water, the pasty mass was placed in a flask, with four volumes of absolute or nearly absolute alcohol and a sufficient quantity of caustic soda in powder. Heat was applied and the vapors disengaged were conducted into three volumes of nitrate of ethyl mixed with two of absolute alcohol, kept cool by a freezing mixture. At the close of the operation it was necessary to add a little water to the contents of the flask in order to complete the decomposition. The absorption of the distillate was complete, and the liquid thus saturated was again enclosed in sealed tubes and heated. The entire number of charges was forty-two, of which five were lost by explosion. For the convenience of those who may use this method of obtaining the ethyl bases, I give the results which I observed as to the strength of tube necessary:

Tubes of one inch external diameter, weighing
5 ounces to the foot generally burst.
6 to 7 " " generally resisted, but not always.
8 to 10 " " were found safe.

This refers to tubes charged from three-sevenths to one-half. Beyond this charge, greatly increased strength becomes necessary.*

The disposition to burst appeared to be greater in the second heating than in the first. It is therefore better to heat for 11 or 12 hours to 180°–190° F. rather than risk the loss of products which have already cost considerable time and trouble.

In describing the properties of ethylamine and diethylamine, I have shown that when nitrate of ethyl is made to react upon ammonia, the resulting alkaloids are easily separated from each other by means of picric acid. It is a familiar fact that when several salts are present in one solution, the facility of separating them by crystallization will often depend upon the relative proportion in which they are present, and this holds good in the present case. When ammonia acts upon nitrate of ethyl, and the bases, after separating the ammonia, are converted into picrates, we have a mixture of the salts of ethylamine and diethylamine in nearly equal quantities, with a variable quantity of triethylamine, always very small and sometimes a mere trace, always separating out in the first crystallization. But when nitrate of ethyl is made to react again upon the products of the first reaction, the proportions of the alkaloids are very different. Diethylamine then constitutes about three-fourths of the whole, and the residue is chiefly triethylamine mixed with some ethylamine. When these bases are converted into picrates the diethylamine salt still separates with great facility, sinking to the bottom at a certain stage of concentration as a heavy oily fluid.† Previously to this,

* It has been very generally recommended in text books to wrap pressure tubes in cloths to prevent the explosion of one from destroying the rest. When this is done, the extremities of the tube should always be left clear. It is at the extremity that the explosion almost always takes place, and if there is not an easy escape for the expanding vapors, so great a disturbance follows that much damage may be done. In this way I have seen every tube in a boiler broken by the explosion of one, whereas, since I have adopted the plan of leaving the ends perfectly free, when an accident has taken place I have always escaped with the loss of the one.

† The latter portions of this oily fluid which separate are often pasty with the needles of the less soluble compounds, from which they are best separated by ether in which picrate of diethylamine is extremely, and the other picrates very sparingly soluble. As a proof how exactly diethylamine may be separated from its cognate bases by conversion into picrates, I subjoin analyses made at various times, some of which have been published before, others not:

(1.)	·7144	gramms chloroplatinate gave Pt,	·2552
(2.)	·9961	" "	·3549
(3.)	·3884	" "	·1377
(4·)	1·9129	" "	·6764

These correspond to

(1.)	Per cent platinum, - - - -	35·72
(2.)	" " - - - -	35·63
(3.)	" " - - - -	35·45
(4.)	" " - - - -	35·36
	Theory requires (Pt=98·7) - - -	35·35
	" " (Pt=99) - - -	35·45

the picrates of ethylamine and triethylamine crystallize out in yellow needles. The separation of these last from each other by crystallization when the triethylamine is present in considerable proportion, cannot be as satisfactorily effected, as when it is present in small quantity only. It therefore became necessary to seek for a good mode of effecting this separation.

Triethylamine is but moderately soluble in water, and when the water present is insufficient to dissolve it, it forms a layer on the surface. It seemed possible that its affinity for ether might be greater than for water, and experiment proved this to be the case. When ether is agitated with aqueous solution of ammonia, ethylamine, or diethylamine, it takes up but little of the base, but when agitated with aqueous solution of triethylamine, it becomes strongly charged. A portion of ether agitated with a mixture of the aqueous solutions of ethylamine and triethylamine and then treated with hydrochloric acid and bichlorid of platinum and spontaneously evaporated, gave only crystals of triethylamine salt, which is easily distinguished from the platinum salt of ethylamine: no traces of the presence of the latter were observable. It therefore seemed worth while to test the process by a careful series of analyses, which was done with the following results.

The moderately strong aqueous solution of the mixed bases, triethylamine and ethylamine, was agitated several times with about $\frac{1}{10}$ its bulk of ether and left some time to separate thoroughly, after which the ether was removed by a separating funnel. This was repeated three or four times. It was evident that if these ethereal solutions of triethylamine thus obtained were contaminated with ethylamine, the latter substance would be present in largest proportion in the latter portions of the ether. In order therefore to render the test more rigorous, these latter were examined in preference, and with the following results.

Portions of the etherial solution were treated with excess of hydrochloric acid and converted into platinum salt with excess of bichlorid of platinum.

(1.)	·7031 gms. substance gave metallic platinum,	·2264
(2.)	1·2084. " " "	·3873
These correspond to		
(1.)	per cent platinum, - - - -	32·20
(2.)	" " - - - -	32·06
	Mean of two analyses, - - -	32·13
	Theory requires (Pt=98·7)* - -	32·13

An eminently satisfactory result.

In order to ascertain if the whole of the triethylamine were removed by this proceeding, the aqueous solution, after four washings with ether, was submitted to analysis. Its chloroplatinate gave by ignition

* I have taken this number for Pt as that adopted by the last numbers of the Jahresbericht.

·6373 substance, platinum,	- - - - -	·2487
Corresponding to, per cent platinum,		39·02
Theory requires,	- - - - -	39·29

The number found falls a little below the theoretical proportion, and may indicate that a trace of triethylamine remained in the aqueous solution. I may however remark that this slight discrepancy is within the error of a careful analysis, particularly with substances whose analysis requires so much circumspection as these. Two analyses of chloroplatinate of ethylamine of which the alkaloid had been separated by picric acid gave respectively 39·02 and 39·23, the first of which numbers is identical with that above found.

Ether appears therefore to afford a convenient mode of separating ethylamine and triethylamine, after diethylamine has been eliminated by means of picric acid. This is a necessary condition: when observed, the process gives, so far as my experiments go, good results.

Properties of Triethylamine.

Triethylamine is an oily fluid lighter than water, and floating on its surface when the water present is insufficient in quantity to hold it in solution. When therefore the crystallized hydrochlorate is added to a concentrated solution of caustic soda, the triethylamine separates and rises to the surface. It has an agreeable ammoniacal odor, which appeared to me to be pleasanter and more aromatic than those of ethylamine and diethylamine. This however is a matter on which it is difficult to speak positively, as the odor of ammonias appears to be influenced by adventitious circumstances. Stas found the oder of perfectly pure ammonia prepared by him, to be quite different from that ordinarily recognized as characteristic of the substance.

It is not very soluble in water, but emulsifies very easily with it. When a stratum of triethylamine is resting upon the surface of a saturated aqueous solution, a very slight agitation is sufficient to produce a complete emulsion, and a considerable time elapses before the stratum separates again. It is capable of acting under some circumstances as a reducing agent, separating gold in the metallic state with production of aldehyd, as will be described further on, but unites with chromic acid without decomposition.

Reactions of Triethylamine with solutions of metallic bases.

The following reactions were obtained with a saturated aqueous solution of pure triethylamine:

Zirconium, sulphate of Zirconia,	White precipitate, insoluble in excess of precipitant.
Aluminium, tersulphate alumina,	White precipitate, dissolving readily and completely in excess of the precipitant.

Glucinum, sulphate of glucina,	White precipitate, insoluble in excess of precipitant.
Cadmium, sulphate,	White precipitate, insoluble in excess of precipitant.
Zinc, sulphate,	Same reaction.
Nickel, chlorid,	Green precipitate, insoluble in excess of precipitant.
Cobalt, protochlorid,	Greenish blue precipitate, insoluble in excess of precipitant.
Lead, neut. acetate,	The white precipitate dissolves in excess of lead solution, but is insoluble in any excess of triethylamine.
Tin, protochlorid,	White precipitate, insoluble in excess of precipitant.
" bichlorid,	White precipitate, dissolving completely in excess of precipitant.
Silver, nitrate,	Brown precipitate, somewhat soluble in excess of precipitant.
Gold, terchlorid,	Yellow precipitate, insoluble in excess and speedily becoming blackish.

The action of triethylamine on gold solution is remarkable and may be considered as the most distinctive characteristic between this and the allied alkaloids. Triethylamine added to terchlorid of gold throws down a yellow precipitate, which in a few moments darkens and soon appears black, but examined in thin layers is found to be dark bluish green. This precipitate treated with hydrochloric acid partly dissolves with formation of terchlorid and leaves a residue of metallic gold in the form of a brown powder. The precipitate at first formed by the alkaloid speedily passes therefore into protoxyd of gold. This reduction is accompanied by the evolution of aldehyd, and is carried even further than the production of protoxyd, part of the gold being reduced to the metallic form. For after standing a few minutes, a bright film of gold collects on the surface of the liquid, and after a few hours the sides of the test glass are found to be covered with a brilliant speculum of metallic gold.

Platinum, protochlorid,	No precipitate.
" bichlorid,	A saturated aqueous solution of triethylamine gives no precipitate with a concentrated solution of bichlorid of platinum.

Palladium, protochlorid,	No precipitate.
Ruthenium, sesquichlorid,	No immediate precipitate. The liquid however soon begins to darken, and a black precipitate falls, which gradually increases until the liquid is decolorized.
Antimony, terchlorid,	Reddish brown precipitate.
Uranium, nitrate,	Abundant yellow crystalline precipitate, insoluble in excess of precipitant.
Mercury, ternitrate,	Yellowish white precipitate, insoluble in excess.
Molybdenum, protochlorid,	Becomes opalescent and by standing deposits a yellowish powder.*
" bichlorid,	Brownish yellow precipitate, insoluble in excess of precipitant.
Chromium, potash chrome alum,	Greyish green precipitate, insoluble in excess of precipitant.
Iron, ferric ammonia alum,	Brown, insoluble in excess.
Copper, sulphate,	Blue precipitate of which not a trace redissolves in excess of the alkaloid. The precipitate after treatment with a large excess of saturated aqueous solution of triethylamine, was filtered and the filtrate tested with sulphydrate of ammonia, which gave not the slightest indication of the presence of copper.
Manganese, protosulphate,	Brownish white, insoluble in excess of precipitant.
Magnesia, sulphate,	White precipitate, insoluble in excess.
Cerium, protochlorid,	White precipitate, insoluble in excess of the precipitant.
" nitrate of protoperoxyd,	Same reaction.

Reactions with Hydrofluosilicic Acids.

Aqueous triethylamine treated with ordinary hydrofluosilicic acid, $HFl, SiFl_2$, gives, when the alkaloid is in excess, a precipitate which readily dissolves in an excess of the acid.

With Knop's hydrofluosilicic acid $2HFl, Si_2Fl_3$ no immediate precipitate is formed even when the alkaloid is in excess, but after standing some hours, it becomes a slightly opalescent but almost transparent jelly, so stiff that the test glass may be inverted without spilling it.

Observations on these Reactions—I have already pointed out that the property of redissolving precipitates of alumina, heretofore considered as characteristic of ethylamine, is shared by both diethylamine and methylamine, and expressed the opinion

* Methylamine also precipitates solutions of this salt. My correction of the contrary statement in the last number of this Journal (p. 369) reached the editors when the impression was too far advanced to alter it.

that it might probably be found to extend to the other ethyl and methyl bases. The result above stated affords a confirmation of this view as regards the base now under examination.

The most important points deducible from the above described reactions may be summed up as follows: Towards solution of aluminium, cadmium, nickel, protochlorid of cobalt and bichlorid of tin, the behavior of triethylamine is the same as that of ethylamine and diethylamine, and differs from that of ammonia. With respect to zinc, the behavior of triethylamine resembles that of diethylamine and differs from that of both ammonia and ethylamine. In speaking of the reactions of diethylamine, I pointed out that the oxyds of silver and copper were the only ones redissolved by all three bases, ammonia, ethylamine and diethylamine. We now see that only one, silver, is dissolved by all four, including that here investigated.

Extending the comparison to methylamine and denoting by (W.), reactions observed and recorded by its discoverer, M. Wurtz, with respect to that substance, we find that gold precipitates redissolve in excess of methylamine, but not in excess of triethylamine. Protochlorid of palladium is precipitated by methylamine, and not by triethylamine. Alumina is precipitated and redissolved by both. Zinc, silver, and copper precipitates are redissolved by excess of methylamine (W.) but are insoluble in triethylamine. With respect to cadmium, nickel, and cobalt, the precipitates from solutions of these metals are insoluble in methylamine (W.) and in triethylamine.

Finally we observe that those reactions which may be considered as being eminently characteristic of triethylamine, are those which it exhibits with gold and with copper. These and these only, differ essentially from the reactions of ammonia, ethylamine, diethylamine and methylamine respectively. That with gold solution is especially interesting.

Salts of Triethylamine.

Hydrochlorate.—Crystallizes with great facility in beautiful snow-white feathery laminæ. It is not in the least deliquescent in tolerably dry air;—a portion left exposed for several days in a watch glass did not exhibit the least tendency to liquify. Carefully heated on platinum foil, it disappears without leaving any carbonaceous residue.

The most curious property of this salt is its easy combustibility. A portion of the dry salt readily ignites by contact with a lighted match and burns with a livid green flame.

Sulphate.—Very soluble in water and alcohol. Exposed over lumps of caustic soda, in vacuo, for some weeks, it solidifies to an indistinctly crystalline mass. Heated on platinum foil, it takes fire and burns with a scarcely luminous flame and yellowish scintillations.

Nitrate.—The nitrate of triethylamine appears to be liquid at ordinary temperatures, and is obtained by neutralizing aqueous triethylamine with nitric acid, gently evaporating at a low temperature until the solution is somewhat concentrated, and then placing in vacuo over caustic soda for some weeks. A thick syrupy liquid is thus obtained which does not crystallize. When filtering paper is imbued with this liquid and brought near to a flame, it deflagrates with a sudden flash.

A double sulphate of zinc and triethylamine isomorphous with the double sulphates of Mitscherlich's group does not appear to exist.

Art. VIII.—*Notes on American Fossil Fishes;* by Dr. J. S. Newberry.

In the progress of geological investigation in North America the remains of a large number of fishes have been brought to light, and are now preserved in the various collections, public or private, in different parts of the country. Most of these have been described by Redfield, Gibbes, Jackson, Leidy and myself, but as the descriptions given of them are scattered through a multitude of works, some out of print, and most not readily accessible to the student, I have been frequently requested to publish a *resumé* of what is known of our fossil fishes, with references to the papers in which they are described.

This I now propose, as briefly as possible to do, and for convenience, will divide the subject into several parts, according to the formations in which fossil fishes have been found.

I. Fishes of the Devonian Formation.

Up to the present time no well marked remains of fishes have been discovered in the Silurian rocks of this continent, but, as in the old world, in the Devonian strata they are not unfrequent. By far the largest number of specimens and species have been obtained from the Corniferous limestone of western New York, Ohio, and Indiana. The Portage group in Ohio, and the Catskill in New York and Pennsylvania have also furnished a number of fish remains but of different genera from those of the Corniferous.

The papers which contain descriptions of our Devonian fishes are as follows:

Dr. D. D. Owen and Dr. J. G. Norwood: "Description of a new fossil Fish from the Palæozoic Rocks of Indiana."—Amer. Jour. Science, [2], vol. i, p. 367. 1846.

Prof. Joseph Leidy: "Description of some remains of fishes from the Carboniferous and Devonian Formation of the United States."—Journal Acad. Nat. Sciences Phil., [2], vol. iii, p. 159, 1856.

Prof. Wm. Hopkins, "On a remarkable fossil," &c.—Proc. American Association, 1854, p. 287.

Dr. J. S. Newberry: Fossil Fishes of the Cliff Limestone of Ohio.—Annals of Science, vol. i, 1853.—Proc. Amer. Assoc., 1853, p. 166; Bulletin of the National Institute, 1857, p. 119.

Of these the last contains descriptions of all the species which up to that time had been collected in the Corniferous limestone of Ohio, about a dozen in number, including representatives of three genera supposed to be new. These species are as follows:

Agassichthys Manni, N. (=*Macropetalichthys.*)
" *Sullivanti*, N. "
Machaeracanthus major, N.
" *peracutus*, N.
" *sulcatus*, N.
Onychodus Hopkinsi, N.
" *sigmoides*, N.
Psammodus antiquus, N.
Oracanthus fragilis, N.
" *granulatus*, N.
" *abbreviatus*
" *multiseriatus*

The three genera proposed in this paper, namely, *Agassichthys*, a large cœlacanth ganoid; *Onychodus*, represented by a group of placoid teeth, and *Machaeracanthus*, based on some remarkable unsymmetrical double-edged spines, as they are characteristic of the formations in which they are found, and of considerable zoological interest, seem to require a few words of descriptive comment.

Of these, the first, I am now satisfied includes the ichthyic cranium described by Doctors Owen and Norwood under the generic name of *Macropetalichthys*. The specimen described by these gentlemen was found in the Cliff limestone at Madison, Indiana. When it came into their hands, it was much broken. As a consequence the description based upon it was very imperfect, and in some respects erroneous, and, as will be seen, sure to mislead any one who might discover other representatives of the genus to which it belonged. Dr. Owen described his fish as "being entirely destitute of a tubercled dermal surface; as without distinct eye-orbits; provided with two spinous appendages, or horns, and having the scutcheons covered with angular, irregular, rhomboidal, enamelled, but minute scales," all of which is entirely at variance with the characteristics of the large number of crania which I have examined, derived from the same formation, and which, judging from a plaster cast of the original which I have seen, are generically identical with that described by Dr. Owen.

This fish, which must now be known by the name of *Macropetalichthys*, is not only of interest to the palæontologist and zoologist as the most characteristic vertebrate of the epoch of the Corniferous limestone on this continent—the ganoid monarch of our Devonian seas,—but also as furnishing additional evidence of the parallelism of our lower Devonian strata with the limestones of the Eifel; for a species of this genus, probably identical with one of ours, has been discovered in that formation and locality, and is described and figured by the distinguished palæontologist Hermann von Myer, (Palæontographica, vol. i, p. 102, T. xii).

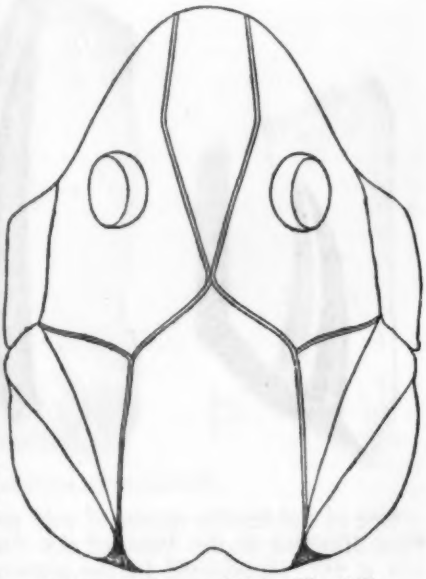
By von Myer this fish was referred to the genus *Placothorax* of Agassiz, but as I have shown in the paper read before the National Institute, von Myer, misled by the distortion of his specimen, has mistaken the occipital for the nasal extremity of the cranium; and further that it could not be included in *Placothorax*, but must be referred to another genus and another family. The present state of our knowledge of this genus may be comprehended at a glance from the following description and figure.

Genus MACROPETALICHTHYS, Owen.

Agassichthys, Newb.
Placothorax, v. Myer, not of Agassiz.

Desc.—Cœlacanth ganoids of large size, cranial surface covered with thickly set stellate tubercles in lines radiating from various centres, or without regular arrangement. Cranium composed of large polygonal plates united by double sutures which are nearly concealed by the tubercled enamel surface. Eye orbits conspicuous and included in the orbital plates. Teeth in two rows, conical, curved, acute, smooth, not plicated at base nor dendritic in structure. Scales obscurely rounded, the exposed portion ornamented with small tubercles and fine divergent raised lines, the covered portion marked with lines of growth, and finely reticulated as in *Rhizodus*, &c.

1.



Cranium of *Macropetalichthys Manni*, N., half natural size.

Of *Macropetalichthys* there are now enumerated four species, viz:

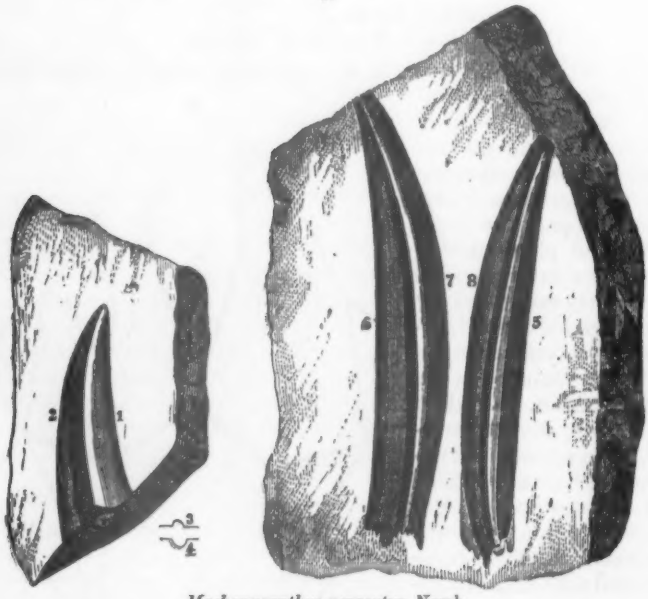
M. Manni, Newb.	*M. Agassizii*, v. Myer, sp.
M. Sullivanti, Newb.	*M. rapheidolabis*, Owen.

It is however possible that the last two are identical with the two former, but just what Owen's species is we shall probably never know, as his description does not tell us and the original specimen has been lost sight of—neither does von Myer's figure and description furnish the means of making an accurate comparison with the American fossils.

Genus MACHÆRACANTHUS, Newb.

Spines often of large size, flattened, curved, ancipital, unsymmetrical, dextral and sinistral; edges and point generally acute; base somewhat narrowed, with a rough and irregular extremity; central cavity large,—reaching nearly to the apex; external surface covered with a thin coating of enamel, in some species smooth, in others punctate or longitudinally striated; microscopic structure that of dense ivory-like bone.

2.



Machæracanthus peracutus, Newb.

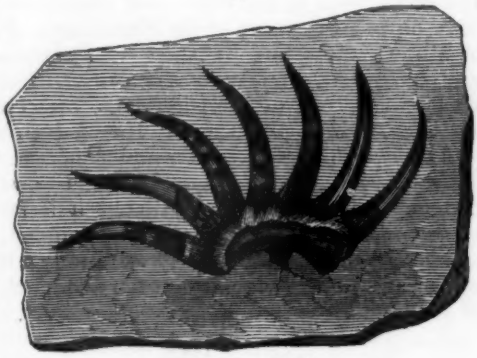
One of the smaller species of this genus is that described by Prof. Hopkins in the Proc. of the American Association, vol. viii, p. 287, represented by the accompanying wood cut, taken from that volume.

These spines are very characteristic of the horizon of the Corniferous limestone; having been found in Indiana, various localities in Ohio, in New York and at Gaspé, C. E. Though presenting some anomalous characters, (among which the most remarkable is their want of symmetry, being rights and lefts), it is hardly possible they can be anything else than the defensive spines of placoid fishes. Their dense bony structure, enamelled surface, and their rough and irregular bases, would seem to prove that like the fin-spines of many sharks and rays they had been implanted in the integuments without articulation. Possibly they were the first rays of the pectoral fins, which would account for their being in pairs, but in that case we should expect to find the bases exhibiting some marks of their articulation to the thoracic arch. Some of these spines are more than a foot in length, double-edged and very sharp, constituting most formidable weapons of attack or defense. My friend Dr. Wm. Stimpson, whose knowledge of Crustacea is so minute and so general, is decidedly of the opinion that they could not have belonged to a crustacean.

Genus Onychodus, Newb.

Teeth in rows of seven or more, set upon an arched base, from which they radiate. They are much curved, have a circular section toward the summit, are somewhat compressed below, and expand at base into several prominent roots or tuberosities, of which the most conspicuous are on the side toward which the point is curved. They have a central cavity extending nearly to the point, surrounded by dentine, simple in structure, the external surface covered by a layer of smooth and polished enamel.

3.



O. Hopkinsi, Newb.

These are apparently the teeth of sharks, generally detached from the cartilaginous jaws, and scattered through the limestone in which they are found; a row of them, however, occasionally retaining their connection, as is the case with *Helodus*, *Orodus*, &c. of the Mountain limestone, *Hybodus* and *Acrodus* of the Jurassic strata.

In addition to the fishes of the Corniferous limestone enumerated in the preceding pages, fragments of the armor of large Placoderm Ganoids have been found which have been referred to *Coccosteus* and *Cephalaspis*, but more and better specimens will be necessary to prove that these genera were represented in our Devonian seas. A number of placoid spines and teeth have also been taken from the Cliff limestone of Ohio, which have not yet been described.

In the upper members of the Devonian formation, the number of fossil fishes yet discovered in this country is small. A species of *Palæoniscus* obtained by Prof. Brainard from the Portage group in northern Ohio, (*P. Brainardi*); two species of *Holoptychius* from the Catskill of New York, another with a placoid spine from the same formation in Pennsylvania, complete the catalogue.

Of these the *Palæoniscus*, described by Mr. Thomas, is apparently a good species, and is interesting from its antiquity. The two New York species of so-called *Holoptychius* have, I believe, never been critically examined, and it is by no means certain that they are such. That described by Dr. Leidy from Pennsylvania is a well marked species of this genus, evidently closely allied to *H. nobilissimus* of Europe.

It will be noticed in the foregoing sketch that no mention is made of many of the most characteristic genera of fishes of the Devonian rocks of the old world, and up to the present time we have no proof that any of the Placoderms, *Asterolepis* (*Pterichthys* of Miller), *Coccosteus*, *Cephalaspis*, *Pteraspis*, &c., of the Cœlacanths, *Homostius* (*Asterolepis* of Miller), *Bothriolepis*, *Dendrodus*, *Psammosteus*, &c., of the Dipterians, *Dipterus*, *Osteolepis*, *Diplopterus*, &c., or the Acanthians, *Acanthodes*, *Diplacanthus*, *Cheirolepis*, &c. ever had any existence in America.

The evidence on this point is of course as yet only negative, and may all be soon reversed, but it is nevertheless rather remarkable that while most of the Devonian molluscous genera, and many species are common to the two continents, the fishes so far as known are all specifically distinct, and the larger part of them generically different.

(*To be continued.*)

ART. IX.—*Experiments on the formation of Infusoria in boiled solutions of organic matter, enclosed in hermetically sealed vessels, and supplied with pure air;* by JEFFRIES WYMAN, M.D., Hersey Prof. of Anatomy in Harvard College.

PASTEUR in his admirable researches on fermentation has brought forward experimental evidence to show that this process depends upon the presence of minute organisms in the fermenting fluid and that the source of all such organisms is the atmosphere. In support of this opinion he asserts, that when a fluid containing organic matter in solution is put into a flask and "boiled two or three minutes," and supplied only with air which has been filtered by passing through a tube heated to redness, and the flask is then hermetically sealed, no fermentation takes place, no organisms are formed, and that the contents remain indefinitely without change. But if the same solution is exposed to the air in its ordinary condition, it becomes filled with various living forms. Out of a large number of experiments prepared in the manner above described he has not known one to give a different result from that mentioned.[1] He further states that if the neck of the flask is drawn out into a very slender curved tube of several inches in length, the contents boiled, and then allowed to cool without the end of the tube being closed, so that the air enters at the ordinary temperature, and has free access to the interior of the flask, even then no fermentation takes place and no organisms appear. His explanation of this is, that the air which enters first, meets with the hot steam, and the spores or organisms contained in it are killed; while those which enter the tube later move more slowly and are deposited on the moist walls of it without entering the body of the flask.[2]

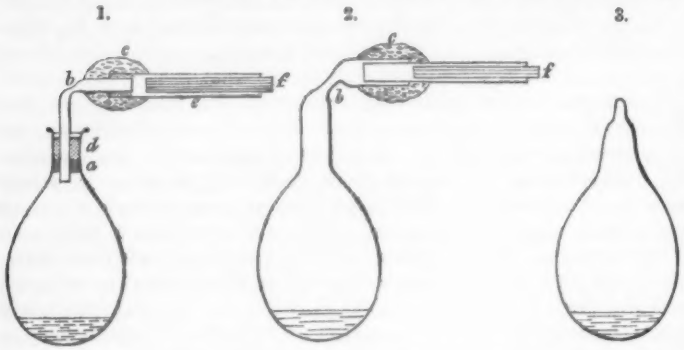
In most of the experiments given below the results have been quite different, and living organisms have made their appearance, in some instances where even greater precautions were taken than those mentioned by Pasteur. In order that the reader may understand what precautions were taken we shall first describe the manner in which the experiments were performed.

(1.) In some instances (as in Expts. i to v, vii to xi, xiii to xv,

[1] "J' affirme avec la plus parfaite sincerité, que jamais il ne m'est arrivée d'avoir une seule experience disposée comme, je le viens de le dire, qui m'ait donné un seul resultat douteux."—*Annales des Sciences Naturelles*, T. xvi, IVme Serie, 1861, p. 33.

[2] "Il semble que l'air ordinaire rentrant avec force dans les premiers moments doit arriver tout brut dans le ballon. Cela est vrais, mais il rencontre un liquide encore voisin de la temperature de l'ebullition. La rentrée de l'air se fait en suite avec plus de lenteur et, lorsque le liquide est assez refroidie pour ne plus pouvoir enlever aux germes leur vitalité, la rentrée de l'air est assez relentée pour q'il abandonne dans les courbures humides du col toutes les poussieres capable d'agir sur les infusions, et d'y determiner des productions organisées."—*Ann. des Sc. Nat.*, 1861, T. xvi, p. 60.

xxix and xxx inclusive) they were prepared as in fig. 1. The materials of the infusion were put into a flask, and a cork *a*, through



which was passed a glass tube, drawn to a neck at *b*, was pushed deeply into the mouth of it. The space above the cork was filled with an adhesive cement *d*, composed of resin, wax and varnish. The glass tube was bent at a right angle, and inserted into an iron tube *e*, and cemented there with plaster of paris *c*. The iron tube was filled with wires *f*, leaving only very narrow passage ways between them.[3]

(2.) Others (as in Exps. vi, xii, xvi to xxiv, and xxxi to xxxiii inclusive,) were prepared as in fig. 2, in which the joining at *a*, fig. 1, is avoided, and the iron tube is cemented directly into the mouth of the flask, the neck of which is drawn out at *b*, to render the sealing of it easy; otherwise the conditions are the same as in fig. 1.

(3.) In other experiments (as in Exps. xxiv to xxviii, and xxxiv to xxxviii inclusive,) the flask, fig. 3, was sealed at the ordinary temperature of the room, and submerged during the period of the experiment in boiling water. This was the method followed by Needham and Spallanzani and has the merit of eliminating all suspicions of error which might be supposed to arise from some imperfections in the joinings.

In the first and second methods, the solution in the flask is boiled, and at the same time the iron tube filled with wires is heated to redness. While the contents are boiling the steam formed expells the air from the flask; when the boiling has continued long enough, the heat is withdrawn from beneath the flask, and as the steam condenses, the air again enters through the iron tube, the red heat of which is kept up, so that all organisms contained in the air are burned. In both methods the flask is

[3] An advantage in preparing the experiment in this way is, that the same flask may be used many times.

allowed to cool very slowly in order that the entering air may be as long as possible in passing through the iron tubes, and thus the destruction of its organic matters insured. When cold the flasks are sealed at *b*, figs. 1 and 2, with the blowpipe.

In experiments xxix and xxx, a glass tube filled with asbestos and platinum sponge was used instead of the iron tube filled with wires.

The time during which the infusions were boiled varied as will be seen by the records, from fifteen minutes to two hours, and the amount of infusion used was from one-twentieth to one-thirtieth of the whole capacity of the flask, the object being to have the materials exposed to as large a quantity of air as possible.

In the account which follows, especial mention is made, in most instances, of the time of the formation of the "film." This is always the first indication which can be had, without opening the flasks, that minute organisms are developed; it is in fact made up entirely of them, as has been proved by repeated examinations with the microscope. It may first be detected in small patches, but soon covers the entire surface, and if the flask is gently moved so as to cause the infusion to change its position, the film adheres to the glass and is left by the liquid. In a few of the experiments no such film was formed.

After the flasks were prepared they were suspended from the walls of a sitting room near the ceiling, where they were exposed to a temperature of between 70° and 80° F. throughout the day and nearly the same during the night.

Exp. I.[4] (1.)[5] Feb. 3d, 1862. A few grains each of sugar, gelatine and fine cut hay were introduced into a flask of 500 cub. cent. capacity, 20 cub. cent. of water were added and the whole thoroughly boiled. A film formed on the surface of the fluid on the 8th day, the flask was opened on the 9th and found to contain large numbers of Bacteriums.

Exp. II. (1.) Feb. 3d. This was prepared in the same way as the preceding, excepting that pepper was added to the solution. The flask was opened on the 29th day and Bacteriums were found in great numbers.

Exp. III. (1.) Feb. 4th. A few grains of cheese, sugar and gelatine were dissolved in 17 c. c. of water, filtered and boiled in a flask of 500 c. c. capacity. A film formed on the 19th day, the flask was opened on the 36th and found to contain Bacteriums.

Exp. IV. (1.) Feb. 4th. Twelve cubic centimetres of a solution like the preceding, with the addition of a small quantity of

[4] In the first seven experiments the time which the contents were boiled is not stated, but it was in no instance less than fifteen minutes.

[5] The figures in brackets following the number of the experiment indicates which of the three modes of preparing the experiment was made use of.

pepper was boiled in a flask of 250 c. c. capacity. It was opened on the 20th day, but no living organisms were found.

Exp. v. (1.) Feb. 5th. A solution of sugar, gelatine, and cheese was boiled and filtered, and again boiled in the flask, which was opened on the 29th day, and no organisms detected.

Exp. vi. (2.) Feb. 10th. A solution of gelatine and sugar to which was added a few drops of urine and milk, were put into a bolt-head, the tube of which had been drawn to a neck, and after boiling, was hermetically sealed. The flask was opened on the 13th day and found to contain yeast plants and some very slender filaments which appeared to be of a vegetable nature.

Exp. vii. (1.) Feb. 10th. Twenty cubic centimetres of a solution like the preceding was boiled in a flask of 875 c. c. capacity. A film formed on the 11th day, and on the 30th the flask was opened and found to contain Vibrios and Bacteriums.

Exp. viii. (1.) Feb. 25th. A solution of sugar and gelatine to which fragments of green leaves and flesh were added, was boiled 1^h and 40^m. The flask was opened on the 15th day; no organisms were found.

Exp. ix. (1.) Feb. 25th. The same as the preceding, without the addition of the flesh; this solution was boiled 40′ and opened on the third day; no organisms were found.

Exp. x. (1.) March. 6th. Three flasks, *a b c*, were prepared in the same way, each containing a solution of sugar and gelatine to which was added a few drops of urine and some fragments of muscle; *a* and *c* were boiled 30′ and *b* 1^h. Air was supplied to *a* and *b* through a heated tube and to *c* at the temperature of the room. A film formed in *a* on the 11th and in *c* on the twelfth day, and at a later period in *b*. They were all opened a few days afterwards and found to contain Bacteriums, Vibrios and ferment cells.

Exp. xi. (1.) March 12th. An ounce of meat was suspended in a flask of 850 cub. cent. capacity with about 40 c. c. of water in it. This was boiled 20′, during which time the meat was exposed to the steam in the flask. The juice which dropped from the meat was coagulated in the water beneath, and the meat itself was thoroughly cooked; on the second day the meat was covered with a gelatinous exudation, and on the third a film was formed on the surface of the water. The flask was opened on the fifth day and found to contain Vibrios, Bacteriums, and a few ferment cells. The gelatinous exudation on the surface of the meat also contained the same organisms, and appeared to be wholly made up of them.

Exp. xii. (2.) March 13th. The juice of an ounce of beef, to which was added 10 cub. cent. of urine and 40 c. c. of water was boiled 20′ in a bolt-head and hermetically sealed. A film formed on the 4th, and the flask was opened on the 11th day, when there was a distinct rush of air outwards. Large numbers of Bacte-

riums were found, also small spherical bodies with ciliary motions and oval bodies like Kolpoda, containing what appeared to be Bacteriums; one of these Kolpoda-like bodies moved with cilia.

Exp. XIII. (1.) March 15th. An ounce of beef was suspended over water in a flask of 500 c. c. capacity and boiled 25′. The same changes took place as in the preceding experiment. The exudation appeared on the surface of the meat, and the film on the water on the 2d day; on the 4th day the meat fell to pieces; the flask was opened on the 9th day; Bacteriums were found in large numbers and there was a slight odor of putrefaction.

Exp. XIV. (1.) March 17th. Juice of beef and a few shreds of beef were boiled in a flask of 300 cub. cent. capacity for 20′. A film was formed on the 2d day and the flask was opened on the 11th day. Bacteriums existed in abundance.

Exp. XV. (1.) March 19th. Fifty cubic centimetres of beef were boiled 40′ in a flask of 800 c. c. capacity. The film began to form on the 2d day, and the flask was opened on the 24th. The film had disappeared, the fluid had a nauseous odor and the Bacteriums were diffused through the whole mass instead of being mostly confined to the surface as in the preceding experiments.

Expts. XVI, XVII, XVIII, XIX, (2.) March 20th, were made with juice of beef and water in flasks of 550 cub. cent. capacity; xvi was boiled 15′, the film formed on the second day and the flask was opened on the 9th. Vibrios were found in abundance, of different lengths, some of them moving with great rapidity. xvii was boiled 30′, the film was formed on the 3d and the flask was opened on the 9th day. Vibrios were found in great numbers, some of them bending and extending themselves rapidly. Some minute spherical bodies were also seen, having the kind of motion which results from vibrating cilia, though none of these were detected. xviii was boiled 15′, the fluid having been previously filtered; the film formed on the 3d, and the flask was opened on the 8th day; the organisms found were the same as in xvii. xix was boiled 1^{h}. The film formed on the 2d and the flask was opened on the 24th day. The infusion had a slightly putrid odor and contained Vibrios and Bacteriums.

Exp. XX. (2.) March 22. The flask and the contents of it were the same as in the experiments just described. The solution was boiled 15′. The film formed on the 5th, and the flask was opened on the 31st day. The fluid had become of a dark reddish brown color, the film had disappeared, and some of the shreds of the coagulated albumen had become nearly black. Bacteriums were found in large numbers, and the darker shreds seemed to be made up of them.

Exp. XXI. (2.) March 27th. Beef juice was boiled 40′; the flask was opened on the 25th day, and found to contain Bacteriums.

Exp. XXII. (2.) April 2d. Beef juice and fragments of beef were boiled 15′, and the air was introduced through a much smaller tube. Bacteriums were found on the 20th day.

Exp. XXIII, (2,) April 5th, was prepared in the same way as the preceding experiment. The film formed on the 6th day, and the flask was opened on the 17th. The sealed end was melted in the flame of a spirit lamp, when the gas escaped with force. Bacteriums were found.

Expts. XXIV, XXV, XXVI, (3,) were all prepared in the same way, April 16th. The capacity of the flasks was 550 c. c.; the contents were beef juice and water 17 c. c., urine 7 c. c. The flasks were folded in a napkin, immersed in water, which was gradually heated to the boiling point, and each then exposed to it for 30′. The film formed in xxvi on the 4th day, and in xxiv and xxv on the 5th, and were all subsequently found to contain Bacteriums.

Expts. XXVII, XXVIII. (3). April 24th. Two flasks, each of 550 c. c. capacity, and each containing about 20 c. c. of beef juice and urine, were hermetically sealed at the temperature of the room, wrapped in cloth, and exposed for two hours to boiling water. The film formed on the 4th day; one of them was opened on the 5th and the other on the 11th, and both found to contain Bacteriums.

Expts. XXIX, XXX. (1.) February 17th. In both of these the contents of the flasks were solutions of sugar and gelatine in water, to which fragments of cabbage leaves were added. The air was introduced through a Bohemian glass tube, filled with asbestos and platinum sponge, and heated to redness. The materials were boiled 30′. In xxix the film was formed on the 29th, and the flask was opened on the 39th day. The solution was found to contain Bacteriums and cells filled with them. In xxx the film was formed on the 7th day, and Bacteriums were found on the 23d, when there was a slight odor of putrefaction.

Expts. XXXI, XXXII, XXXIII. (2.) March 24th. 30 grains of sugar, 20 c. c. of beef juice, 158 c. c. of water, were divided into three parts, and each part put into a flask of 550 c. c. capacity, and boiled 15′. No film was formed in either of them. xxxiii was opened on the 30th day; ferment cells and some filaments of a doubtful vegetable appearance were found. xxxii was opened on the 42d day, and contained ferment cells and monads. An escape of gas took place when the flask was opened. xxxi was opened on the 43d day, and found to contain ferment cells in large numbers, in different stages of cell multiplication; as in xxxii, there was an escape of gas.

Exp. XXXIV. (3.) March 27th. Juice of mutton, in a hermetically sealed flask, was boiled 5′ in a Papin's digester, under a pressure of 2 atmospheres. A film formed on the 4th day. It was opened several days later, in the presence of Prof. Gray, and

found to contain Vibrios and Bacteriums, some of them moving with great rapidity.

Exp. XXXV. (3.) The same as the preceding, and boiled in Papin's digester 10′ and under the pressure of 5 atmospheres. No film was formed. The flask was opened on the 41st day. Monads and Vibrios were found, some of the latter moving across the field. No putrefaction; the solution had an alkaline taste.

Exp. XXXVI. (3.) March 28th. Beef juice was filtered and boiled, as in the preceding experiment, 15′, under 2 atmospheres. Opened on the 41st day, and no evidence of life was found. When the end of the flask was heated, previously to opening, it collapsed.

Exp. XXXVII. (3.) March 28th. The same as the preceding; boiled 15′, under 5 atmospheres. Opened on the 41st day, and no evidence of life was detected.

We have here a series of thirty-three experiments, prepared in different ways, in which solutions of organic matter, some of them previously filtered, have been boiled at the *ordinary pressure* of the atmosphere for a length of time, varying from 15 minutes to 2 hours, and exposed to air purified by heat. In four instances, viz., in Expts. iv, v, viii, x, the contents of the flasks were unchanged at the time they were opened; but in all of the rest, Bacteriums, Vibrios, or other organisms appeared. In nearly every instance their presence was indicated, in the early stage of the experiments, by the formation of a film, which took place in some on the 2d, and in others not until the 19th day, and was afterwards proved by a careful examination with the microscope. Prof. Asa Gray witnessed the opening of some of these flasks, and satisfied himself of the presence of Infusoria in the contents. Vibrios, Bacteriums and Spirillums were the most frequently found, and in addition to these, as in Expts. x, xi, xii, xxix, xxxi, xxxii, xxxiii, either ferment cells, monads, or Kolpoda-like bodies were seen, some of them having ciliary movements. Those forms which were observed the most frequently are among the lowest, if not the lowest of all known organisms.

In many instances, a solution like that in the sealed flasks, and boiled for the same length of time, was exposed to the ordinary air of the room, in an open flask. Although the same forms were found in the two, they appeared much more rapidly in the open than in closed vessels, and the contents of the former soon became putrid, while those of the others, at the time of opening, were mostly not, and in a few instances only slightly so.

We have, in addition, four experiments, viz., xxxiv, xxxv, xxxvi, xxxvii, made under *increased pressure*, and sealed by the third method; xxxiv and xxxvi were boiled 5′ and 10′ respectively, under 2 atmospheres, and xxxv and xxxvii, under 5 atmospheres for 10′ and 15′ respectively. Evidence of life, con-

sisting of Monads and Vibrios, was found in xxxiv and xxxv, but none in the others.

The result of the experiments here described is, that *the boiled solutions of organic matter made use of, exposed only to air which has passed through tubes heated to redness, or enclosed with air in hermetically sealed vessels and exposed to boiling water, became the seat of infusorial life.*

The experiments which have been described throw but little light on the immediate source from which the organisms in question have been derived. Those who reject the doctrine of spontaneous generation in any of the forms in which it has been brought forward, will ascribe them to spores contained either in the air enclosed in the flask, or in the materials of the solution. In support of this view it may be asserted, that it has been proved by the microscopical investigations of Quatrefages, Robin, Pouchet, Pasteur and others, that the air contains various kinds of organic matter, consisting of minute fragments of dead animals and plants, also the spores of cryptogamous plants, and certain other forms, the appearance of which, as Quatrefages says, suggests that they are eggs.[6] We have made some examinations of our own on this subject, but it would be unnecessary to give the results in detail. We will simply state, that we have carefully examined the dust deposited in attics, also that floating in the air collected on plates of glass covered with glycerine, and have found in such dust, in addition to the debris of animal and vegetable tissues, which last were by far in the greatest abundance, the spores of Cryptogams, some closely resembling those of Confervoid plants, and with them, but much less frequently, what appeared to be the eggs of some of the invertebrate animals, though we were unable to identify them with those of any particular species. We have also found grains of starch in both kinds of dust examined, to the presence of which Pouchet was the first to call attention. When compared with the whole quantity of dust examined, or even with the whole quantity of organic matter, both eggs and spores may be said to be of rare occurrence. We have not in any instance detected dried animalcules which were resuscitated by moisture, and when the dust has been macerated in water none have appeared until several days afterwards, until after a lapse of time, when they would ordinarily appear in any organic solution.

Those who advocate the theory of spontaneous generation, on the other hand, will doubtless find, in the experiments here recorded, evidence in support of their views. While they admit that spores and minute eggs are disseminated through the air, they assert that no spores or eggs of any kind have been actu-

[6] See an abstract of Pasteur's researches on Spontaneous Generation, this Jour., xxxii, 1, 1861.

ally proved by experiment to resist the prolonged action of boiling water. As regards Vibrios, Bacteriums, Spirillums, etc., it has not yet been shown that they have spores; the existence of them is simply inferred from analogy. It is certain that Vibrios are killed by being immersed in water, the temperature of which does not exceed 200° F. We have found all motion, except the Brownian, to cease even at 180° F. We have also proved by several experiments that the spores of common mold are killed, both by being exposed to steam and by passing through the heated tube used in the experiments described in this article. If, on the one hand, it is urged that all organisms, in so far as the early history of them is known, are derived from ova, and therefore from analogy, we must ascribe a similar origin to these minute beings whose early history we do not know, it may be urged with equal force on the other hand, that all ova and spores, in so far as we know anything about them, are destroyed by prolonged boiling: therefore, from analogy we are equally bound to infer that Vibrios, Bacteriums, &c., could not have been derived from ova, since these would all have been destroyed by the conditions to which they have been subjected. The argument from analogy is as strong in the one case as in the other.

Cambridge, May 9th, 1862.

Art. XI.—*Geographical Notices.* No. XVII.

KILIMANJARO, THE SNOW COVERED EQUATORIAL PEAK OF AFRICA.

The proceedings of the London Geographical Society, vol. vi. No. 2, 1862, contain a very important letter from Mr. R. Thornton, F.R.G.S., (lately attached to Dr. Livingstone's Zambesi Expedition as Geologist) respecting his visit, in company with Baron Carl von der Decken to the much talked of snow-covered mountain, near the equator on the eastern coast of Africa.

The existence of such a mountain, named Kilimanjaro, was reported several years ago by the missionaries of the London Church Missionary Society at Rabbai Mpia. One of them, Mr. Rebmann, saw the snowy peak for the first time in May, 1848, and subsequently saw it again. The next year in November, his colleague, Dr. Krapf, saw the same white-topped summit. Neither of them ascended the mountain,—but the natives gave an account of their experience in going up it. They said that "the silver like stuff when brought down proved to be nothing but water," and that many who climbed the mountain returned with frozen extremities which some ascribed to evil spirits. These reports awakened much ridicule in England. The exist-

ence of a snow peak was declared by excellent authority to be highly improbable; the story of the natives was laughed at, and the missionaries were said to have mistaken white stones and rock for snow. Dr. Petermann however and some others defended the probability that the missionaries were right, but on both sides there has been a desire to have the question settled.

At last we have a satisfactory confirmation that there is such a snow-covered mountain, twenty thousand feet high, more or less, lying almost exactly on the equator. Baron von der Decken, who had expected to follow up Dr. Roscher's explorations of the Southern central lakes, being frustrated in this plan, went north with the English geologist who had left Dr. Livingstone's party, and together they have visited Kilimanjaro, or Mount Ndjaro. Von der Decken has written Dr. Barth an account of their observations, (see Berlin Zeitscrift, Dec. 1861,) and Thornton has written to London. We append the letter of the latter, as we find it,—his geological observations having not yet been made public. The reading of the letter at the meeting of the Royal Geographical Society called forth some strong expressions of satisfaction from several distinguished geographers. Mr. W. D. Cooley still disputes (in the London Athenæum) the truth of the reports.

"Our route lay from Mombas to the southwest over the Shimba, thence northwest to the Kadiaro, then southwest to the Pare, then north to the Lake Yipe, thence through Dafeta to Kilema, where we made one attempt to ascend the Kilimanjaro, but had to turn back at about 8000 feet. We then went round by the foot of the mountain to Madjami; thence we returned by Dafeta, Lake Yipe, Pare, and the north foot of Usambara, to Wanga on the coast, which we reached on the 101st day from Mombas. We have made a tolerable map of our journey, the country through which we passed being very favorable for triangulation; though, from not being allowed to ascend the mountains of Pare and Usambara, and the want of two or three stations which circumstances prevented our taking, the map is not nearly so complete as I could wish it to be. The triangulation is checked by several latitudes and a lunar distance at Kilema. I have not yet plotted out the whole of the map, but I hope to complete and send it shortly.

Our journey, on the whole, has been tolerably successful. We did not succeed in reaching to top of Kilimanjaro; but I have its altitude from six different stations, connected by tolerable triangles, at distances varying from 15 to 50 miles. From these I believe the height of the Kilimanjaro to be about 20,000 feet. Its shape varies much, as seen from different points of view; but, from all places we have seen it, its base rises very gradually from a great plane. The outline of the top, as seen from Madjami, is a great dome (but this face is nearly flat): as seen from the east, it is conical, with the apex cut off, forming a little plane, sloping a little to the north. The southern slope of this cone is much steeper than the northern. Several miles to the northeast of the top a great conical peak rises to about 17,000 feet; and about 50 miles to the

west of Kilimanjaro a great conical mountain, named Meru, rises from the great plain of the Massai to perhaps 18,000 feet.

As seen from the east, the snow forms only a thick cap to the Kilimanjaro, with a broad tongue creeping down the south slope; and when the sun is high, several long streaks of snow are seen lying in small ravines descending from the cap. As seen from Madjami, the snow partially covers the southwest face of the dome (about a quarter the height of the mountain), but several large bare patches of rock show out above the snow. The snow here seems to lie at its steepest possible angle, so that fresh snow falling on this slide must at once slip down to the foot of the face of the dome. In one evening, at Madjami, we saw three such slips of snow in about an hour's time. On the eastern peak a few patches of snow are seen when the sun is high.

All parts of the mountain we saw are composed of lava of subariel origin. From not reaching the top, and having seen only the southeast, south, and southwest parts of the mountain, I cannot speak with certainty of its structure; but I think that the Kilimanjaro is the northeastern part of an old subariel volcano, the southwestern and larger part having sunk down several thousand feet, and been partially broken up by faults. The great fault separating these two parts lies about northwest and southeast, and forms a very steep, long flat southwest face to the mountain; and a high, very rugged mountain mass, lying a few miles to the north of Madjami, may be the relics of the top of the original mountain.

We have not reached the axis of structure of Eastern Africa; but very far to the southwest from Kilema are seen, on a clear day, three very high rugged mountains (as high as the Meru mountain), with conical tops, which, if not volcanic—and I think their sides are too steep and shapes too irregular for ordinary volcanoes—may be composed of the axial granite.

The Lake Yipe is shallow, and rapidly filling up. You will see its size and position best when I send you our map. On its north side it receives the River Loomi (of Rebmann), and at its west end sends out a river which, after joining the Jagga river, flows south through the plain lying between the Ugona and Anuisha ranges to the river of Pangani. Between the Kilimanjaro and Anuisha ranges is a small watershed, which sends the rivers of Western Madjami to the west.

Mr. Rebmann's map and description, as given in the first volume of the 'Missionary Intelligencer,' give a very fair idea of the country, and, considering he had no instruments, his map is very accurate."

LIVINGSTONE'S EXPEDITION.—THE ROVUMA RIVER.

1. The following letter has been published from Dr. Livingstone dated April 9, 1861. It appears in the Proceedings of the London Geographical Society, vol. vi, No. 1.

"On the 9th of April last, Dr. Livingstone's expedition arrived at Pomony Bay in the island of Johanna, from the river Rovuma. They had ascended the river only 30 miles, when, halting to wood their ship, a mark made on a tree showed that the water was falling at the rate of

6 or 7 inches a day. They had found some parts carrying no more than 5 or 6 feet of water, and as they drew nearly 5 feet, they had to return, lest they should be left fixtures till the flood of next year. The cause of this unsuccessful termination is to be attributed to various delays suffered by the *Pioneer* in the voyage out, making her at last quite two months behind the time for a successful trip up the river. After coaling, they left for the Zambesi, intending to go up the Shiré, and then make a road past Murchison Cataract on that river to Lake Nyassa. The distance is only 35 miles, and it is hoped that they will carry a boat up above the cataracts, and by that means explore the lake.

It is also in contemplation to settle the point whether the Rovuma comes out of the Nyassa, as asserted by all the people they met, before going in the *Pioneer* again to that river. The Oxford and Cambridge Mission accompany the expedition up the Shiré, and it is proposed to place these gentlemen on the plateau of 4000 feet above the sea, on which stands Mount Zomba. There they are likely to enjoy good health while pursuing their enterprise. They have had a good deal of fever, but no mortality. The healthy season begins in May.

The Rovuma will probably turn out to be the best entrance into Eastern Africa. It must, however, be navigated with a vessel of light draught, and with the same skill as is required in the London above-bridge passenger-boats. On the question whether it actually derives its waters from Nyassa, the Doctor thinks that it cannot come out of the Nyassa he discovered, but from some other lake. The reasons he adduces are: the Nyassa is already known to give off one large river the Shiré. This river never rises nor falls more than 3 feet, nor is its water ever discolored. The Rovuma rises and falls 6 or more feet, becomes very muddy, and no instance is known of one lake giving off two large rivers. The probability, therefore, is, that if the Rovuma does come out of a Nyassa or Nyanza (lake, or piece of water), it is some other than that discovered by the expedition. It is well known that lakes having no outlets become brackish in the course of ages. This is the case with Shirwa, but Nyassa and Tanganyika are sweet. The former owes its sweetness to the Shiré flowing out of it. Does Tanganyika owe its sweetness to the Rovuma?"

2. The same number of the Proceedings contains an interesting report, extending through several pages, from Mr. John Kirk, Botanist of the Livingstone expedition, chiefly in respect to such vegetable products of the Shiré and lower Zambesi Rivers, as are in demand in Europe. He reports much of this region as favorable to the growth of cotton, sugar, ground nuts, indigo and cereals. India rubber, coffee, ebony, lignum vitæ are also produced. We copy a few paragraphs on the productions of the Zambesi delta, chiefly for what it says of the cotton culture.

"The countries examined have been those bordering the Zambesi from the east coast to Sesheke, a Makolo town, situated in the centre of the African continent; likewise the valley of a tributary river, the Shiré, from Lake Nyassa to its confluence with the Zambesi near Moramballa Hill. The highlands of the Batoka and Manganja countries have also been vis-

ited. The area thus included extends over 11° of longitude and 5° of latitude; the greatest height above the sea level being 8000 feet.

The Zambesi forms a large Delta, commencing 60 miles from its mouth; the coast for about 8 miles inland is muddy, wooded with mangrove, avicennia, and other trees peculiar to such places within the tropics; the remainder of the Delta consists of rich flat alluvial lands, intersected by many branches of the river. This great tract is covered almost exclusively with gigantic grasses, which keep down all other forms of vegetation, only borassus palms, with a few figs, acacias, or lignum vitæ trees, being able to resist the fires which sweep over these plains during the dry season. The people at present inhabiting the Delta are for the most part fugitives; the slave trade and war have combined to desolate this rich country, which once produced corn, vegetables, and fruits in abundance. Near the coast cotton of an inch staple is found growing wild, having sprung up from seed accidentally scattered; this equals in value much of the Egyptian. Climate and soil are admirably suited, seeing that the plant succeeds so well without cultivation, surrounded by weeds. In the more inland districts it could not raise its head above the dense luxuriance of the other vegetation. The labor required to cultivate cotton here is very small, and the Delta might be made a vast cotton field by encouraging the natives to industry. Many parts of these lands are also suited for the growth of the sugar cane; a little is now raised near the coast, and succeeds well; and it might be raised in most parts even without irrigation. Besides sorghum, pennisetum, maize, setaria, eleusine, and various other sorts of native corn, the Delta also yields wheat during the cold season. Rice of good quality is also cultivated. Tropical fruits succeed well, and near the coast mangos, pine-apples, guavas, cashews, lemons, oranges, and cocoa-nuts are still found where Portuguese settlements had existed in former times.

The climate of the Delta is mild, presenting neither the excessive heat nor cold of the interior; the atmosphere is much moister, and heavy dews are frequent; the prevalence of a sea breeze renders the parts near the coast more healthy than those within the mangroves. The malaria, although an obstacle to the settlement of Europeans, is by no means so intense as that of the west coast; and we have not found a case which resisted treatment, while a cure is commonly effected on the third day. To those passing through or remaining for a short time, there seems to be no danger. But in order that this might become an extensive source of cotton, the permanent residence of Europeans is not necessary; if it were raised by the natives and purchased from them by agents, a steady supply might be depended on; but time would be needed, even under a wise government, to bring the Delta back to a flourishing state." * *

"*Cotton.*—There are two species of the cotton plant cultivated in the countries explored: one of these, known as *Tonje Kaja*, has been in existence for a long time, and may be indigenous; no trace of its introduction can be found; it is found everywhere, but is being replaced by a better sort named *Tonje Manga*, which signifies foreign cotton, and is of modern introduction, having come from the various towns on the east coast. A variety of the Tonje Manga is met with in the interior of the continent, but not found much further east on the Zambesi than the

confluence of the Kafué. This may have been introduced from the west coast.

The Tonje Kaja is, according to situation, either perennial or annual; on the Mangauja Hills it is an annual from 2 to 4 feet high, sown in March and gathered in August. In the valleys it forms a shrub, remaining several years in the soil. It is readily known from the other sort by leaf and seed. The cotton is of very short staple, seldom exceeding half an inch; it very much resembles wool, and adheres strongly to the seed, from which it cannot be entirely removed: this renders it much more troublesome to pick, and an iron roller is employed to facilitate the separation.

The plant is much less prolific than the other, and the only good quality possessed by it is superior strength, on which account some still prefer it. It is the most universally distributed, being seen everywhere from the coast to the valley above the Victoria Falls and along the course of the Shiré. In the region shut off from the coast by Lake Shirwa, it becomes the only sort grown; but the foreign kind is advancing from both north and south, and fast displacing it.

Tonje Manga, the sort of recent introduction, is, like the other, annual or perennial; it is superior in every respect, and attains a much greater size. The staple varies from half an inch to an inch and a quarter, has great luster, and separates from the seed, which has a clean black coat. What is now produced on the Zambesi and Shiré equals much of the Egyptian, and might be improved by the judicious selection of seed. But there is no necessity for the introduction of new seed, what is now grown on the Shiré being of good quality and very prolific. The variety of Tonje Manga found in the central African valley above the Victoria Falls and as far down as the confluence of the Kafué, differs in the cohesion of the seeds of each cell which form a mass, from the exterior of which the cotton separates easily. The plant attains a great size, and continues seemingly for an indefinite time. Among the ruins of the old town of Sesheke a single plant was measured with a woody stem 8 inches diameter and covering a space of 12 feet. This year it had yielded an abundant crop of cotton $\frac{3}{4}$ of an inch in fiber.

Having found cotton throughout the whole extent of country explored, we know what quality may certainly be obtained, while much more may be expected from careful cultivation. The only cotton seed brought by us, superior to that already in the country, was the Sea Island variety: this yielded excellent cotton $1\frac{1}{2}$ inch long when grown under the most disadvantageous circumstances, and the plant still continues at Tetté, although uncared for. Nowhere have we seen cotton which would not be worth exportation, but the best is that of the Manganja country, where the people have given it much attention; thence it might also be exported with least expense, while Europeans, settled in the neighboring highlands, could direct and superintend the natives of the valleys.

The Delta is excellent cotton ground, but unfit for Europeans, and the present population is very thin and unsettled. Beyond Kebrabassa the Zambesi valley both below and above the Victoria Falls, with the Batoka highlands, might produce a vast supply, and the Batoka hills present a healthy station for residents; but the difficulties at present connected with

the rapids of Kebrabassa render this an inferior position in which to commence such an undertaking, which is to be regretted, as the people of the interior seem more disposed to industry than those of the coast.

The specimens of cotton contained in the collection sent to the Royal Gardens at Kew exhibit fully the different qualities found on the Lower Zambesi and on the Shiré. Since then, others have been added from the interior, showing that the cotton grown there is but little inferior."

3. Following this report of Mr. Kirk, is an entertaining account by Mr. Charles Livingstone of the Batokas and the country they inhabit, lying between the 25th and 29th degrees E. long., and 16th and 18th degrees S. lat.,—west and north of the Zambesi.

YORUBA AND THE NIGER VALLEY.

The British government for a number of years past has bestowed much attention upon the commercial aspects of Western Central Africa, and especially upon the region bordering upon the Gulf of Guinea, including the Valley of the Niger and its great confluent the Benue, and also the countries west of these rivers, comprising Yoruba, Dahomey and Ashantee.

1. The expedition of Dr. Baikie up the Niger has been repeatedly mentioned in these notices. Although it gave promise of important results, we have but little information in respect to what it has accomplished and there is reason to apprehend that it has failed to perform what was expected. Dr. Baikie has been recalled by the Foreign Office, and his apology for not complying with their order has recently been made public.

2. Two intelligent men of color from this country, Dr. M. R. Delany and Mr. Robert Campbell, having visited the Yoruba district with a view to ascertain its fitness for African colonists from the United States, have done much to awaken an interest in that part of Africa and to direct the attention of observing persons to its commercial capacity. A volume published by the latter and a pamphlet by the former of these travelers have contributed to this result. Their impressions of its attractiveness to colonists are decided, and they urge upon their countrymen to go out and engage in trade and manufacture under formal assurances of welcome and protection from the chiefs of Abeokuta, the chief town of Yoruba. Since the return of Messrs. Delany and Campbell at the end of 1860, the condition of our country has been such as to absorb completely the attention of those who would otherwise have been interested in their statements. But public men in England, with their usual commercial sagacity, have been quick to recognize the opening of a new and rich centre of trade, and to appreciate the importance of establishing over it the influence if not the dominion of British power. Shortly after, perhaps in consequence of the publication of Dr.

Delany's observations, the British government seized the little island of Lagos, which is the key to the rich Yoruba lands. Since the seizure, various explorations have been made of the adjacent country. It is not the place to discuss here the political objects of these investigations, but they are well worthy of notice.

3. Captain Richard Burton, the well known traveler, having returned to England from his visit to Salt Lake City, Utah, has been appointed British Consul at Fernando Po. His energy and his practical acquaintance with the difficulties of African travel will enable him to help forward efficiently, from that post, investigations of the interior. He has signalized the beginning of his consulship by visiting Abeokuta, and making in connection with Captain Bedingfield, a minute survey of the River Ogun, on which the town is situated. His visit was made in October and November last. The mouth of the Ogun or Abeokuta he found very much choked up by the delta deposits and the growth of grass,—but beyond he found the main river, a goodly stream one hundred yards broad, skirted by fine forests and little affected by the tide. A brief account of his journey was communicated in a letter to Dr. Norton Shaw and printed in the Proceedings of the London Geog. Soc., vol. vi. no. 2. His impressions of Abeokuta were not very agreeable, but he confirms the estimate of its immense size, saying that travelers have underrated its population at 100,000,—it is probably 150,000. Dr. Delany estimates the number of inhabitants at 110,000; Mr. Bowen, in his "Central Africa," at from 60,000 to 100,000. The extreme circumference of the walls is about 27 miles. We make one extract from Burton's short and rambling letter.

"There is no mistake, however, about cotton growing in these regions. It can be carried out all over Yoruba; a kingdom once extending from the Volta river to the Niger, and including Benin and Dahomey: but, to give it due extension, wars must cease and treaties must be made with the several chiefs. I would here correct a mistake, universally made by those who have written upon the subject. The land is not, as stated by Mr. Campbell and others, common property, nor will the people allow strangers to take it. Litigation upon the subject is quite as general as in England; and if, as Sir Culling Eardley proposes, free negroes and mulattos were sent here from America, there would follow the agrarian wars and troubles of New Zealand. Even in the towns a stranger cannot obtain building ground, except it be granted with the understanding that it is not alienated in perpetuity, but shall revert, when no longer in use, to the original proprietor.

If you want a colony in West Africa, send it to me, near the Cameroons. At some future time I will (D. V.) enter fully into the subject. Suffice it to say for the present that Lagos requires a sanatorium—the nearest now being Teneriffe and Ascension: and the Oil rivers want a

key, after losing Fernando Po. At Abeokuta the cotton is grown in the farms. I was shown the green seed or upland (short staple), and the black seed or long staple. There is, moreover, a very valuable kind, called "akashe," soft as silk. Eight seeds are sold for a penny. Before the war, the export was doubling every year; since then it has declined. The Cotton Association of Manchester exported 20,000 bales in 1859–60, and received only 3447. With the return of peace it will revive. The wars are conducted in the usual African style. Seventeen thousand men meet, blaze away with "long Danes" from the hip all the day, retire and advance, as if by mutual consent, and separate with the loss of half a dozen killed and wounded: and this stuff they call fighting! It is serious only to the allies, who, being weaker than those who assist them, are sold off by way of commissariat. The Egbas of Abeokuta are nominally fighting to defend their friends the Ijáyes against a common foe, the Ibadans. It is generally asserted that the unhappy Ijáyes have at this time lost 20,000 of their number by famine and the slave market. The real *casus belli* lies deep; the Abeokutans are determined to monopolize transit dues by keeping the northern people from the coast. Every African tribe knows that it cannot prosper without seaboard, and then the war began."

4. Commander Dolben, R.N., in H. M. S. Bloodhound, has recently visited the river Volta, which empties into the Gulf of Guinea, near Lagos, a little west of the Ogun river. He found the bed not impassable, as had been reported, but covered with eleven feet of water. Four of his boats manned by thirty nine men went up the river in October last. The party ascended the stream 120 miles when their voyage was brought to an abrupt close by rapids.

"Though impracticable to ship's boats, the rapids are not absolutely impassable, for the small strong native canoes can be forced through them to Pong, a town which is situated at their head, 5 miles above the furthest point reached by the expedition. Above Pong the Volta is again navigable. Its stream was considerable. Immediately below the rapids it had a depth of 10 feet right across from bank to bank and a width of three-quarters of a mile. The natives were a fine race of men. The climate appeared healthy; for none of the party suffered during the five days they were in the river, notwithstanding exposure and severe work. The principal products were cotton, palm oil, Indian corn, and cassava. The water of the river was palatable, and fish abundant."

DR. HAYES'S ARCTIC VOYAGE.

Dr. Hayes's engagements have been such that no full record of his voyage to the North has yet been prepared. In a private letter received from him he says that the report of his remarks published in the Proceedings of the American Philosophical Society is the most trustworthy account of his journey. "One thing," he continues, "does not appear to have been noticed which is of some national importance, though of none commer-

cially. The land which I discovered and surveyed during this cruise is the most northern land known on the globe. I have traced it to 82° 40′ and have planted the flag of the Union ('with not a single star erased') upon it."

METEOROLOGICAL RECORD AT KANAGAWA, JAPAN, 1860.

In the absence of much trustworthy information in respect to the meteorology of Japan, the following table, recently communicated to us in the Japan Herald, vol. i, No. 2, possesses interest. The Register was kept by Rev. Mr. Hepburn, a missionary of the American Presbyterian Board. We understand that he continues to keep a like record. It is to be regretted that a barometric register does not accompany the other observations.

Table of Meteorological Observations at Kanagawa, from 1st November, 1860, to 1st November, 1861.

	Average of Thermometer at sunrise.	Average of thermometer at 2 P. M.	Maxim'm of thermometer for the month.	Minimum of thermometer for the month.	No. of clear days.	Cloudy days.	Rainy days.	Inches of Rain.	No. of shocks of earthquake.	Snowy days.	Inches of Snow.
1860.											
November.....	45·80	58·36	68·00	36·00	18	7	5	1·85	4	..	....
December.....	38·86	50·87	71·00	22·75	19	4	7	3·40	2	1	50·00
1861.											
January.....	33·00	43·30	55·00	26·50	12	12	3	4·21	1	4	8·50
February.....	37·50	47·00	69·00	27·00	12	4	11	4·20	4	1	2·25
March	39·00	52·00	64·00	31·00	13	8	9	3·95	2	1	....
April.....	53·00	62·30	73·00	39·00	4	11	15	9·26	2	..	....
May.....	60·00	69·30	76·00	44·00	10	10	11	5·42	1	..	....
June.....	69·00	79·00	88·00	60·00	15	3	12	9·83	3	..	....
July.....	76·00	85·00	91·30	71·00	15	8	8	1·33	2	..	....
August	79·00	87·00	90·00	75·00	17	4	10	4·79	1	..	....
September	71·00	87·00	89·00	61·00	13	6	11	4·54	2	..	....
October.....	58·30	67·30	75·00	47·00	11	7	13	6·50	2	..	....
Yearly average.	55·03	65·70			159	84	115	59·28	26	7	11·20

SCHLAGINTWEIT'S INDIA AND HIGH ASIA, VOL. II.

The second volume of the text and the second number of the atlas of the truly imperial work on India by the Brothers Schlagintweit has recently been given to the public. The text is devoted to the Hypsometry of the regions visited. It contains in all the heights of 3,495 points, of which 1,615 belong to India, and 1,880 to High Asia, the area over which they are distributed extending from the southern part of Ceylon to the environs of Kashgar in Turkistan (from 6° to 39° N. lat.) and from the Eastern boundaries of Assám to Sindh (from 97° to 70½° long. E. Gr.). The authors state that of the 3,495 points above mentioned there are 1113 for which they had no other

determination than their own; of these new data 378 belong to India and 735 to High Asia. Besides these they had occasion to add 144 points, some of which were determined anew and others were points for which differential values only had been formerly given and which were now connected with the level of the sea. It is said to have been a matter of serious consideration how to arrange so large a number of heights,—and the plan finally adopted does not seem to us free from weighty objections. India and High Asia are divided into Areas, upon principles which the authors do not mention. Through each of these eleven areas, a line is drawn connecting some of the principal places, and the succession of the heights determined to the right and left of this line, follows its mean direction as indicated by an arrow. These areas are designated as meridional, longitudinal, diagonal or transversal according to the relative position of the leading lines, and are enumerated as follows:

A. India.

Area I. Assám and delta of the Brahmapútra and Ganges, with the Nága, Khássia and Gárra hills, and some remarks about the Iravadi.
Longitudinal, from east to west: Brahmakúnd viâ Rajmahál to the Sánderbans.

" II. Hindostán along the Ganges. Longitudinal, from west to east: Saháranpur viâ Khánpur to Rajmahál.

" III. Pánjáb to Gujrát. Meridional, from north to south: Atak viâ Mithánkôt to Diú.

" IV. Central India. Meridional, from north to south: from the Ganges viâ Nágpur and Chánda to Koríngа.

" V. Dékhan and Maissúr. Diagonal, from northwest to southeast: Bombay viâ Púna and Bellári to Madras.

" VI. Karnátik and Nilgiris, with an appendix on Ceylon. Longitudinal, from west to east: Madras viâ Bangalur and Utakamand to Kalikat.

B. High Asia.

Area VII. Himálaya of Bhután, Sikkím, and Nepál. Longitudinal, from east to west: Bhután viâ Darjíling to west of Kathmándu.

" VIII. Western Himálaya, from Kámaon to Hazára. Diagonal, from southeast to northwest: Almóra viâ Símla and Srinagger to Rajáur.

" IX. Central chain of Western Tíbet. From southeast to northwest: east of the Mansaráur lake to Skárdo.

" X. Principal snow peaks of the western parts of the Karakorúm chain. From east to west: east of the Namur lake to west of the lake Sirikúl.

Area XI. Transversal sections across Tíbet, partially continued across the Kuenlúen. *a.* Níti—Gártok. *b.* Vángtu—Pangkóng. *c.* Kárdong—Karakorúm chain. *d.* Pádum—Leh. *e.* Múlbe—Kiúk Kiol—Elchi. *f.* Dras.—Shígar—Yárkand. *a–e*, are diagonal lines from southwest to northeast, *f*, is a meridional line from south to north.

These lines are considered to be situated in the centre of an area, limited by half their mutual distance.

At the conclusion of the tables of measurements which occupy the greater portion of the volume, some general remarks are made in respect to (A.) the different varieties of Elevated Habitation, (B.) the Geographical Configurations, and (C.) Physical Phenomena.

The volume of plates which accompanies this text contains several Panoramic Profiles of the snowy ranges of High Asia, and six landscapes beautifully printed in oil colors.

Following these Geographical Notices, will be found an extract from the text presenting in a condensed form the general conclusions of the authors on the Indian Himalayan hypsometry, with comparisons of the Alps and Andes.

UNITED STATES GOVERNMENT SURVEYS.

For the following information the readers of the Journal are indebted to Dr. F. V. Hayden.

The following is a brief synopsis of the contents of the several scientific reports, either already prepared or in an advanced state of preparation, for the U. S. Government:

(1.) *North-Pacific Exploring Expedition*, under the command of Commodore JOHN RODGERS, U. S. N. The war has interfered with the completion of this report, as the Commander of the Expedition, with several of his officers, are in active service on the Southern coast, and the appropriations for the department of Natural Science have ceased. The narrative by Capt. Rodgers has not yet been written. Many charts of portions of the Chinese and Japanese seas, and also of parts of the N. E. Asiatic coast to the Aleutian Islands, are finished.

The following reports on the Natural History are in progress: On the Zoology, by Dr. Wm. Stimpson, assisted by Dr. A. A. Gould, Mr. John Cassin, Dr. Hallowell, Dr. Uhler, Mr. Barnard and Prof. Theo. Gill. The zoological portion will probably comprise about 3 vols. 4to, with an atlas of plates for each.

A Report on the Botany, by Prof. Asa Gray and Charles Wright, is in progress.

(2.) *San Juan Exploring Expedition*—Col. J. MACOMB, U. S. Topographical Engineer, commanding. A very beautiful map of the region explored has been constructed, comprising Northern New Mexico and Southern Utah. The report of Col. Macomb is not yet completed, as he is at this time in active service with the Army of the Potomac.

The Geological Report by Dr. J. S. Newberry is finished. The Carbon-

iferous fossils and fossil plants are described by Dr. Newberry, and the Cretaceous fossils by Mr. F. B. Meek. The whole occupy ten quarto plates.

(3.) *Report on Wagon-road Routes in Utah Territory*, under the command of Capt. JAMES H. SIMPSON, Topographical Engineer, U. S. A. This report is quite voluminous, 2 vols. 4to, finely illustrated with plates of scenery, Indians, &c., including a narrative, itineraries, tables of temperature and weather, vocabularies of the Indian languages, maps and charts, by Capt. SIMPSON; a detailed Geological memoir by Mr. H. ENGELMANN; Palæntology, by F. B. MEEK, with 5 quarto plates of fossils; a report on Fishes, by THEO. GILL; Birds and Mammals, by Professor S. F. BAIRD; Botany, by Dr. GEORGE ENGELMANN, of St. Louis. This report has been completed for over a year, and is now in the hands of one of the Congressional Committees, awaiting the order of Congress for its publication.

(4.) *Explorations in Nebraska and Dakota, in the years* 1855–56–57, by Lieut. G. K. WARREN, Topographical Engineer, U. S. Army. Two brief preliminary reports have already been published by the U. S. Government. Whether the entire report will be printed will depend upon the action of Congress. The work will doubtless be resumed again after the war. The Report in progress consists of the narrative of the different expeditions—three in number,—Astronomical, Barometrical and Meterological observations, and maps, profiles, &c., by Lieut. Warren; a report on the Geology of the district traversed, by Dr. F. V. HAYDEN, (completed); Palæontology; report on the Molluscous fossils, 45 quarto plates, over 1,000 figures, between 400 and 500 species new to science, by F. B. MEEK and F. V. HAYDEN, (completed); report on the Fossil plants, by Dr. J. S. NEWBERRY, about 25 plates, 4to, and from 60 to 70 species new to science; Report on the Fossil Vertebrata, by Prof. JOSEPH LEIDY, 10 plates, 4to, (prepared); Reports on the Zoology and Botany, by various authors.

(5.) *Report of the North-West Boundary Survey*—ARCHIBALD CAMPBELL, Esq., Commissioner. The field work of the survey of the North-West Boundary has been completed, furnishing data for a topographical report, embracing the country from the Pacific Coast to the summit of the Rocky Mountains, extending to the north and south of the 49th parallel, north latitude. Astronomical observations locate the Boundary at all the important points, and the surveys and actual measurements connecting these points, extending over 9° of longitude, embrace the topography on and near the line, while the reconnaisances extend to the north and south, thus affording data for the maps that are now in progress to illustrate the report. The report will consist of magnetic observations for declination, also observations for dip and horizontal intensity, made at nearly all the astronomical stations; and, finally, a magnetic survey, extending from the line near the summit of the Rocky Mountains along the usual route of travel, in a southwest direction, to Walla-Walla, crossing several lines of equal degrees of magnetic declination and dip, over a distance of four or five hundred miles.

Meterological observations have also been made at all the camps; a continuous record kept at the principal depots, as at Simiahnoo, for three

years and at Colville depot during eighteen months, furnishing corresponding observations for the barometrical readings taken by the different parties along the line and other routes of travel, thus affording the material not only for a report on the Meteorology of the country, but also for barometrical profiles of the different routes. The work will also be illustrated by a number of views, showing the physical character of the country.

During the progress of the work the eclipse of the sun of July 18th, 1860, occurred, and every exertion was made to secure observations as complete as possible, with a view not only to the difference of longitude along the line, but also to their value as a contribution to science. As the eclipse occurred early in the working season, and the parties were at that time in the most rugged portion of the country, it was with great difficulty that they could reach suitable points on the boundary in time. However, the two astronomical parties were able to get in position, but on account of an unavoidable accident to some of the delicate instruments, only one of the parties succeeded in obtaining observations, and these were made at Camp Mooyie in approximate lon. 116° 10′, west of Greenwich.

In the department of natural history reports have been finished, or are in progress, of the following gentlemen:

Botany, by Dr. JOHN TORRY; Fossil Plants, with plates of new species, by Dr. J. S. NEWBERRY; Marine Invertebrata, excepting Mollusca, by Dr. WM. STIMPSON, with plates; Recent Shells, with plates, by PHILIP P. CARPENTER; Fossil Invertebrata, with plates, by F. B. MEEK; Fossil Infusoria, Mr. ARTHUR M. EDWARDS; Fishes, with the exception of the Salmonidæ, THEODORE GILL, with plates; Monograph of the Salmonidæ, Dr. GEORGE SUCKLEY, with plates of new and unfigured species; Birds, by Dr. GEORGE SUCKLEY and ELLIOT COWES, with special monographs of the Grouse family, by Dr. S., and of the Gulls, Divers and Grelles, by Mr. C., illustrated with plates showing the specific differences of these complicated families; Report on Mammals, by Dr. SUCKLEY, with monographs of some of the smaller animals, by Prof. S. F. BAIRD; Coleopterous insects, by Dr. J. L. LECONTE, and non-Coleopterous, by Mr. P. R. UHLER; several reports on the Geology of the country explored, by GEORGE GIBBS.

(6.) *Explorations of the Upper Missouri and Yellow Stone, during the years* 1859–60, under the command of Capt. WM. F. RAYNOLDS, Topographical Engineer, U. S. A. The progress of this report has been suspended for a time, the commanding officer being on duty, as Topographical Engineer of Gen. Rosencrantz's staff. A map of the region explored has been prepared, and the Astronomical, Barometrical and Meteorological observations, with profiles, &c., are completed. The following reports are nearly ready: Reports on the Geology of the district examined, by F. V. HAYDEN; Palæontology, by Prof. LEIDY, Dr. NEWBERRY and Messrs. MEEK and HAYDEN; Zoology, Mammals, by F. V. HAYDEN; Birds, by ELLIOT COWES; Fishes, by THEO. GILL; Botany, by Messrs. ENGELMEN, DEWEY, SULLIVANT and TUCKERMAN; also a Report on the Ethnography and Philology of the Indian tribes of the Missouri Valley, by F. V. HAYDEN, (finished).

[It is now probable that the Government will be soon able to resume these and other important scientific labors, as soon as the discharge of the officers before engaged on them from active military service shall render it possible to go forward again with peaceful labors. It is a circumstance of happy augury for science that during the progress of the present war, the Government has found on numerous occasions the value of its labors in science, equally in the data before recorded and in the personal services of those whose experience in the various departments of scientific training in the Government service has enabled them to serve their country with an intelligible efficiency not otherwise attainable. Hereafter we have a right to expect less unwillingness on the part of Congress to the measures involving expenditures for scientific purposes. If it were needful it would not be difficult to unite the plea of science to public consideration as demonstrated by the campaign experiences of the last fifteen months.]

Art. XII.—*H. and R. de Schlangintweit on the Geographical Configurations of India and High Asia.**

1. PLATEAUX AND LAKES.

Plateaux, in consequence of their being more or less intersected by deep and broad valleys, or from being covered with ridges, are so variable in their form, that the use of the name, in many instances, appears to be somewhat arbitrary. We prefer not to extend the meaning of the name too far, and in so doing diverge from the practice of earlier travelers, who commonly applied the term to every mountainous region of great *general* elevations—as the natives of the Himálaya have a tendency to do—irrespective of its form.

In *India* there are many plateaux, which, for the most part, lie in the Dékhan, Maissúr, and Málva; they are well defined, but of low elevation, and very limited in extent as compared with those of the Andes or Turkistán. Among the most important are Mahabaléshvar (4,500 ft.), Amarkántak (3,590), and Kondikónda (3,070 ft.).

In the *Himálaya*, which is composed in almost every direction of lofty and irregular ridges, and intersected by numerous valleys of inconsiderable width, no plateau of any extent has been discovered as yet, nor is it at all probable, that one exists.

Western Tibet was for a long time supposed to be little else than a country of plateaux—an erroneous impression emanating from the first observers, though Humboldt, with his usual sagacity, had early pointed out the error of this belief. Plateaux certainly

* Extracted from the Results of a Scientific Mission to India and High Asia by H., R., and A. de Schlagintweit, vol. ii. 4°. Leipsic, 1862.

do occur in Tíbet; they are, however, much less numerous and considerably smaller than we had been led to expect.

Tíbet may be best described, in short, as a longitudinal valley included between the Himálaya and Karakorúm, and covered with many lateral ridges.

In its *eastern part* it is drained by the Dihóng, an affluent of the Brahmapútra. The heighth of its capital, Lhássa, may be estimated at 10,000 ft.

Its *central part* is formed by the gradual rising of the ground in the environs of the lakes Mansaráur and Rákus Tal, the average height being 15,400 ft.

The *western part* is drained by the Indus and Satlej rivers, with their affluents; it comprises Gnári Khórsum, Ladák and Bálti. The principal towns of these provinces are: Gártok (15,090 ft.), Leh (11,527 ft.), and Skárdo (7,255 ft.).

The unusual height of some of the valleys of Western Tíbet, as compared with those in other parts of the globe, may not improbably have a considerable share in the erroneous belief deduced from early reports as to this country being almost exclusively a plateau.

Instances of two river-systems belonging to one general longitudinal depression are not unfrequent on a minor scale, though Tíbet must be considered perhaps as the largest form of this kind. In the Alps, the Upper Engadin with the Val Bergell, and the valley of the Vorder-Rhine with that of the Rhône, can be mentioned as somewhat analagous.

Between the *Karakorúm* and the *Kuenlúen*, especially near the western crest of the former, several well defined plateaux of extraordinary height occur. Some of the highest are called: Dápsang (17,500 ft.), Búllu (16,883 ft.), Aksáe Chin (16,620 ft.), Vohább (16,419 ft.). In Bálti, the plateau Deosái is 14,200 ft. high.

In the *Andes* are to be found, if not the highest, at least the most extensive plateaux of our globe, which generally lie along the very ridge of the mountains. Their average heights differ but little from those of the towns mentioned above.

There is also a large plateau surrounding the elevated lake Titicaca (12,843 ft.).

In the *Alps*, plateaux occur only at their base; the Swiss plateau having a mean height of 1,460 ft., the Suevo-Bavarian plateaux of 1,420 ft.* It is here that the principal Alpine lakes are situated. In the Himálaya there are no such picturesque plains adorning the foot of the mountains. The watershed between the Indus and the Ganges is altogether upon a lower level and no connection with the Himálaya exists, similar to that between the Swiss plateau and the Alps.

* Hermann and Adolphe: "Phys. Geogr. d. Alpen." Vol. ii. p. 577.

Lakes are comparatively rare in India, but large "Jhīls" are occasionally to be seen, especially in the river systems of the Ganges and Brahmapútra. For the most part they are not very deep; their surface is very variable, and many of them are entirely dry during the hot season. *Tanks* are frequently met with; their numbers throughout the country testify the importance attached to them by the natives. Some of the tanks in Maissúr and the Karnátik are of surprising dimensions.

In the *Himálaya* also, there are but very few lakes, That of Nainitál, in Kămáon (6,520 ft.), the Vúllar lake, in Kashmír (5,126 ft.), and the Chinár lake, near Srinagger, at about the same height, suffice to exhaust the category of those deserving mention.

Glacier lakes—accumulations of water formed by one glacier obstructing the outlet of a higher one—are of much more frequent occurrence. At times, the wall of ice breaks away before the pressure of the swollen waters, when the lower lands become suddenly inundated, and the torrent rushes on with uninterrupted violence for miles, exercising a marked influence even down to the lower parts of the rivers.* Two of the most elevated glacier lakes are the Déo Tal, in Gărhvál (17,745 ft.), and the Námtso, or Yunám, in Lahol (15,570 ft.).

Western Tíbet and Turkistán possess many lakes, all of which are situated in great heights; they are however, gradually drying up, as becomes apparent by the unmistakable marks of larger surfaces remaining from former times. They contain a greater quantity of salt than lakes in general, and most of them to an amount which renders them more or less brackish. The water of some, however, is still drinkable; among these we particularly mention the Hánle and the Upper Tsomognalarí lakes.

LAKES OF WESTERN TIBET TURKISTAN.

Aksáe Chin.....	16,620 ft.	Níma Kar.....	15,100 ft.
Tso Gyagár.....	15,693 "	Hánle	14,600 "
Tso Kar, or Kháuri Taluá	15,684 "	Tso Gam.....	14,580 "
Múre Tso.....	15,517 "	Tso Rul.....	14,400 "
Kiúk Kiol.....	15,460 "	Tso Mitbál.....	14,167 "
Mansaráur, or Tso Mápan	15,250 "	Upper Tsomognalarí..	14,050 "
Rákus Tal, or Tso Lánag	15,250 "	Lower Tsomognalarí..	14,010 "
Tsomoríri.....	15,130 "		

2. PASSES.

In *India*, the highest pass is the Sigur, in the Nílgiris (7,204 ft.). The Rangbódde pass, in Ceylon (6,589 ft.), is little inferior in height. Of the numerous passes (Ghāts) occurring in the West-

* Similar inundations, some of them of a most destructive character, have several times occurred in Tíbet. See "Vigne's Kashmír," vol. ii, p. 362, "Cunningham's Ladák," pp. 99, et seq., and "Capt. Montgomerie's Memorandum."

ern Ghāts, the Bapdéo and the Katrúj both exceeded 3,000 ft., the former being 3,499 ft., the latter 3,019 ft.

For *High Asia*, the mean of a sufficient number of such passes which lead over the three principal *crests* is particularly to be taken into consideration, it being approximatively proportional to the mean height of these crests. The passes situate in the lateral ramifications of the principal crests—though they are numerous—cannot be included in these general means, being geographically of subordinate importance.*

The mean height† of passes is as follows, the value being based on the heights contained in the table at p. 106.

a. For the Himalaya..... 17,800 ft.

From Síkkim to Kishtvá; Bhután and Kashmír being excluded; the former for want of materials, and Kashmír on account of the Himálaya there losing the character of one well defined and predominant chain.

b. For the Karakorum..... 18,700 ft.

We have data only from Long. E. Gr. 76° to 79½°, the heights in the eastern continuation being quite unknown.

c. For the Kuenluen ..... 17,000 ft.

Here we know the height of two passes only. As they are situated, however, in parts not differing, in any important particular, from the general character of this chain, they may be looked upon as representatives of the others.

From these numbers it appears, that the Karakorúm has by far the greatest mean height of passes; but the one pass which we must still consider the highest is situated in the Himálaya. This is the *Ibi Gamin pass* (20,459 ft.), leading from Gărhvál to Gnári Khórsum, which we crossed August 22, 1855. It is known to the natives of Mána and Bádrinath, some of whom, about 36 years ago, once ventured to cross it with their laden sheep. The Mána pass at that time was infested by robbers, and the difficulties encountered, as also the loss of sheep and merchandize experienced on this occasion, were so considerable as to induce the natives to give up all idea of using the route as a commercial road.

Some comparisons with other and more familiar instances of elevation will tend to furnish a more adequate idea of the extraordinary height of this pass. The one coming nearest to Ibi Gámin in height, the Mustágh pass in Bálti, is 1,440 ft. lower. We may remark incidentally, that the Ibi Gámin pass is only 1,800 ft. below the highest point attained by us on the peak of the same name. This pass exceeds the highest in the Andes by

* We have had occasion to cross one pass of above 20,000 ft., one above 19,000 ft., six between 19,000 and 18,000 ft., nine between 18,000 and 17,000 ft., &c.

† The precise figures are: Himálaya 17,789 ft., Karakorúm 18,721 ft. and Kuenlúen 16,999 ft.

4,869 ft., Mont Blanc by 4,676 ft., and the highest pass in the Alps by 8,580 ft.

The *Mustágh pass* (19,019 ft.) and the *Ibi Gamin pass* (20,459 ft.) are, however, the only two as yet known above 19,000 ft. The third in height is the Changchénmo, (18,800 ft.), in the Karakorúm chain, but none of these, it should be borne in mind, are generally used, or crossed as commercial roads; they are evidently too high and too difficult of access. The highest pass as yet known to be regularly crossed with horses and sheep, for the purposes of commerce, is the Hárang pass, in Spíti (18,500 ft.); and between this height and 18,000 ft. are situated several of the most important and frequented passes, as the Mána (18,406 ft.), the Karakorúm (18,345 ft.), and the Kióbrang (18,313 ft.). Over none of these, or other high passes, however does anything lead at all approaching to the European idea of a road. Though below the glacier region a kind of foot-path is certainly discernible—very often a row of small stripes running parallel to each other—yet as soon as a glacier is ascended, or one of its ancient or present moraines, all such traces at once disappear. The general direction to be taken is indicated by stones, not unlike glacier tables, which the natives place along the line of route as way-marks; though in many parts, as on the Turkistáni road, north of Ladák, the uncertainty about the path to be followed is often removed by the appearance of the numerous skeletons of beasts of burden which distinguish the tracks of former caravans.

The Himálayan passes above 16,000 ft. are invariably closed by snow during the winter months between November* and May; even in the beginning of June, it is extremely difficult to cross a pass above 17,000 ft.

In the Karakorúm, the snow line is so elevated, and the absolute quantity of snow falling so small, even in winter, that the passes are never entirely closed. The Karakorúm can thus always be crossed even with horses, and the caravan road from Ladák to Turkistán accordingly remains passable throughout the year, though during the cold season, in order to avoid the Sássar pass, one of the most difficult parts of this route even in summer —the merchants prefer going up to the Karakorúm along the Shayók river.

In the Kuenlúen, all passes above 15,000 ft. are, as we heard, closed in winter by the heavy snow-fall.

In the *Andes*, the general mean elevation of the passes is, according to Berghaus:†

* In December, 1845, when the Chinese fought a battle near Tírthapúri, in Gnári Khórsum, the garrison of Tákla Khar fled across the pass near the head of the Káli river. Even in this unopposed flight, one half of the men were killed by frost, and many of the remainder lost their fingers and toes. See "Cunningham's Ladák," 1854, p. 353.

† Berghaus: "Zeitschrift for Erdkunde," vol. ix, pp. 322–6.

For the Western Andes..... 14,500 ft.
For the Eastern Andes..... 13,500 "

The highest passes are: Alto de Toledo (15,590 ft.),* Lagunillas (15,590 ft.), and Assuay (15,526 ft.).†

In the *Alps*, we adopted as the mean for the passes 7,550 ft.

As the highest pass, at least in former times, not unfrequently used for commercial purposes, we may refer to the St. Théodule pass (11,001 ft.).‡ There are, however, besides *indentations* (*Scharten*) practicable for travellers, which are considerably higher,—exceeding 12,000 ft. Among others is the Old Weissthor, which we found to be 11,871 ft.;‡ another pass, the passage to Saas, recently called the New Weissthor, is marked on our map of Monte Rosa with the height of 12,136 ft. The height of the Col du Géant in the Mont Blanc group is 11,197 ft.‡

TABLE OF THE PRINCIPAL PASSES.

A. *In India.*

1. Dékhan.

Name.	Feet.	Name.	Feet.
Bapdéo	3,499	Pochámа	2,446
Katrúj	3,019	Nána	2,429
Par	2,698	Jám	2,328
Nagchérri	2,645	Málsej	2,062
Návi	2,617	Tal	1,912
Sápi	2,478	Bhór	1,798

2. Málva.

Name.	Feet.
Péndera	3,498
Silva	1,928
Mándla	1,626
Póppera	1,560
Gúmba	1,553
Singrámpur	1,437

3. Karnátik, Nílgiris, and Ceylon.

Sígur	7,204	Rangbódde	6,589	Gantvarpílli	2,373
Sispára	6,742	Kodúr	2,401	Kistnaghérri	2,150

B. *In the crest of the Himálaya.*

From Síkkim to Kíshtvaár.

Ibi Gamin	20,459	Umási	18,123	Kiúngar	17,331
Dónkia	18,488	Lángpia	17,750	Níti	16,814
Jánti	18,529	Máyang	17,700	Vallanchún	16,756
Párang	18,506	Lípu	17,670	Púling	16,726
Mána	18,400	Uta Dhúra	17,627	Shínku La	16,684
Nélong	18,312	Birmkánta	17,615	Bára Lácha	16,186
Kióbrang	18,313				

C. *In the crest of the Karakorúm.*

From long. E. Gr. 76° to 79° 30′.

Mustágh	19,019	Changchénmo	18,800	Karakorúm	18,345

D. *In the crest of the Kuenlúen.*

From long. E. Gr. 78° to 80°

Elchi	17,379	Yurungkásh	16,620

* Pentland's Map: "La Laguna de Titicaca and the valleys of Yucay, Collao, and Desaguadero," London, 1840.

† Humboldt's "Ansichten der Natur," vol. i, p. 123.

‡ Hermann and Adolphe: "Phys. Geogr. d. Alpen," vol. ii, pp. 30 and 32.

E. *In the Andes.*

Alto de Toledo... 15,590| Langunillas..... 15,590| Assuay..... 15,526

F. *In the Alps.*

St. Théodule..... 11,001| New Weisthor... 12,136| Old Weisthor.... 11,871

3. PEAKS.*

In *India*, the highest peak, Dodabétta (8,640 ft.),† is situated in the Nílgiris, in Southern India.

Of the peaks in the central parts of Ceylon, the Péduru tálla gálle reaches about the same height, rising up to 8,305 ft.; the well known Samanála, or Sripáda (Adam's Peak), attaining 7,385 ft.

In the mountain chains of Central India, in the *Vindhya* and *Araválli* ranges, the peaks are considerably lower (Abu, 3,850 ft., Rajmirgárh, 3,753 ft.).

The Kalsubái, the highest peak of the Dékhan, attains only 5,410 ft.

High Asia. In the beginning of this century the Andes were supposed to contain the highest peaks on our globe, and Chimborazo to rise supreme above the rest. Though, as early as 1816, this was proved by Captain Webb's measurements, to be incorrect, yet some time elapsed before the superiority of the Himálaya above the Andes was generally admitted. At present (Nov. 1861) the number of peaks on the ranges of High Asia that are known to exceed the highest summit of the Andes, is remarkably great, amounting to forty-five.

In the *Himálaya*,† Gaurisánkar, or Mount Everest (29,002 ft.), is the highest peak in the world yet discovered; it is 6,000 ft. higher than the dominating peak of the Andes, and 13,220 ft. above the most elevated parts of the Alps.

In the *Karakorúm*, peaks have lately been discovered which are scarcely inferior in height to the loftiest in the Himálaya, though only its western part has as yet been explored. With regard to the heights of its eastern continuation, there is not enough known to allow even of an estimate being made.

The highest peaks of the Karakorúm are the Dápsang (28,278 ft.), the Diámer (26,629 ft.) and the Masheribrúm (25,626 ft.).

With reference to the *Kuenlúen*, we can only mention the peaks that we saw between the Yurungkásh pass and the western termination of this chain; our idea about the general height is the more limited, as we have not even itinerary reports of former travellers to assist us. None of the peaks seen there by ourselves exceed 22,000 ft.

* We here exclude, as not properly belonging to the regions to be compared, the countries northeast of Assám, with the Gri peak (15,300 ft.), and the Sóliman range to the west of the Indus, of which the highest peak, the Sufed Koh, rises to 14,839 ft.

† Notwithstanding their great elevation, none of the peaks of the Himálaya are visible from the sea, in consequence of their continental position.

Our volume contains the geographical co-ordinates (latitude, longitude, and height) of 132 peaks belonging to these three mountain ranges, which exceed 20,000 ft. in height, while one of them actually reaches 29,000 ft. (Gaurisánkar, or Mount Everest), and two range between 29,000 and 28,000 ft. (Dápsang and Kanchinjínga).

The relative numbers of the others are:

Relative Numbers.	From	To	Relative Numbers.	From	To
2	28,000 ft.	27,000 ft.	14	24,000 ft.	23,000 ft.
6	27,000 "	26,000 "	26	23,000 "	22,000 "
10	26,000 "	25,000 "	23	22,000 "	21,000 "
10	25,000 "	24,000 "	38	21,000 "	20,000 "

In the *Andes*, important alterations have recently been made with reference to the succession of peaks when arranged according to height, and even now the same amount of accuracy cannot be ascribed to the hypsometrical determination of its principal peaks* as to the trigonometrical operations in the Himálaya. The highest peak in the Andes is the Aconcagua (23,004 ft.); and there are as many as five peaks higher than the Chimborazo (21,422 ft.).

In the *Alps*, Mont Blanc (15,784 ft.) and Monte Rosa (15,223 ft.) are well known to be the highest peaks. In the tables of comparison, we have added a list of peaks above 14,000 ft., but have given the highest summit only in every group, in order not to extend the space unnecessarily.

TABLE OF THE PRINCIPAL PEAKS.

A. *In India.*

1. Nílgiris.

Name.	Feet	Name.	Feet.
Doddabétta	8,640	Kundamóya	7,816
Bevoibétta	8,488	Tamberbétta	7,292
Makúrti	8,402	Kokalbétta	7,267
Daversolabètta	8,380	Urbétta	6,915
Kúnda	8,353	Daverbétta	6,571

2. Ceylon.

Name.	Feet.
Péduru tálla gálle	8,305
Kirigalpótta	7,810
Totapélla	7,720
Samanála, or Adam's Peak	7,385
Namúna Kúli	6,760

3. Central India.

Parisnáth	4,469
Abu	3,850
Rajmirgárh	3,753
Búlbul	3,354

4. Dékhan.

Kalsubái	5,410	Pútta	4,569
Dhórup	4,745	Ikhára	4,482
Varáda	4,655	Aunda	4,339
Tórna	4,619	Mándvi	4,123

B. *In the Himálaya.*

Gaurisánkar	29,002	Yássa	26,680	Nánda Dévi	25,749
Kanchinjínga	28,156	Jibjíbia	26,306	Ibi Gamin	25,550
Síhshur	27,799	Barathór	26,089	Naráyani	25,456
Dhavalagíri	26,826	Yángma	26,000	Jánnu	25,304

* Humboldt's urgent wish to see these heights re-determined has not yet been realized. See his "Kleinere Schriften," p. 158.

C. *In the Karakorúm.*

Dápsang..... 28,278	Díamer..... 26,629	Masheribrúm..... 25,626

D. *In the Kuenlúen.*

The peaks seem not to exceed 22,000 ft.

E. *In the Andes.*

Authorities: *H*=Humboldt; *K*=Kellet and Wood; *P*=Pentland.

Aconcagua..... 23,004 *K*	Gualateiri..... 21,960 *P*	Sorata or Ancohuma... 21,286 *P*
Sahama..... 22,350 *P*	Pomarape..... 21,700 *P*	Illimani..... 21,145 *P*
Parinacota..... 22,030 *P*	Chimborazo.... 21,422 *H*	

F. *In the Alps.*

Mont Blanc..... 15,784	Weisshorn..... 14,813	Grand Combin*.. 14,134
Monte Rosa..... 15,223	Mont Cervin*..... 14,787	Strahlhorn..... 14,100 ?
Täschhorn, or Lagerhorn..... 14,954	Dent Blanche*.... 14,305	Finsteraarhorn ... 14,039

Art. XIII.—*On the Detection of Picrotoxine;* by John W. Langley, S.B.

The seeds of the *Menispermum Cocculus*, known in commerce by the name of Cocculus Indicus, or popularly as "Fish berries," contain several active organic bodies. One of these, picrotoxine, is eminently poisonous and, it has been asserted, possesses in small doses a distinctly intoxicating quality. From this cause, and because the addition of the berries to the fermenting mash enables the brewer to dispense with a large amount of the malt which he would otherwise use, they have been largely employed for the adulteration of ale and beer, so much so in fact that it was deemed necessary in England to pass a law prohibiting its use for this purpose. While the composition and properties of picrotoxine have been long known, no process has been hitherto discovered by which it may be detected with certainty and confidence, the only method now employed being the recognition of its crystals under the microscope.

When picrotoxine obtained by any of the methods usually given for its preparation is examined, it will be found to possess the appearance and many of the properties of the alkaloids with which it has been classed, but it differs from them in the essential particular of not combining with acids, but on the contrary, it manifests a decided affinity for bases and behaves in many respects like a weak acid. Again it differs from them in the fact that if a salt of an alkaloid is decomposed with potassa we can

* The heights are taken from p. 511 of "Peaks, Passes, and Glaciers," edited by J. Ball, London, 1859; the others, for which no modification is known to us since 1854, are from our "Phys. Geographie der Alpen."

remove the organic base by ether from an aqueous solution, while the same course pursued with picrotoxine would fail to remove any of it from the water, it being positively necessary that the solution should be neutral or acid to enable the ether to dissolve it.

Picrotoxine is soluble in one hundred and fifty parts of cold water, but if a small quantity of caustic alkali is present it will readily dissolve in six or eight times its volume. When this solution is gently heated it becomes yellow and on platinum foil at a temperature far below ignition assumes a brick-red color which is distinctive and quite unlike the shade produced by sugar under similar circumstances. Picrotoxine like sugar and many indifferent organic bodies, possesses the property of reducing certain metallic oxyds. "It changes bichromate of potass to a fine green color." (Gmelin.) "An alkaline solution of picrotoxine reduces sulphate of copper to the suboxyd. (Otto.) This property however is common to too many other substances to be at all distinctive. A far more reliable test is found in oxydation.

If dry picrotoxine and nitrate of potassa are rubbed together in a watch-glass and a drop of sulphuric acid is added, no perceptible change occurs, but if a strong solution of caustic soda or potassa is poured upon this a bright reddish-yellow color is communicated to the mixture which partially dissolves and causes the whole liquid to assume the same tint. In this way very minute traces of picrotoxine may be discovered, so small a quantity as $\frac{1}{5000}$ of a gramme, if pure, being detected with the greatest ease. When as small a quantity as this is used we see the color most distinctly by gently breaking the solid cake of sulphate of potassa which lies on the bottom of the dish; portions of the precipitate will then appear of a crimson or purple hue.

In applying this test it is best to add about three or four times the quantity of nitrate of potash that we have of substance to be examined and to use no more sulphuric acid than is necessary to moisten the mass. The solution of potassa or soda should be made very strong and enough added to ensure considerable alkalinity in the mixture after the neutralization of the sulphuric acid.

Other powerful oxydizing agents will produce the same result but not with equal facility; chlorine passed over the moistened crystals, slowly dissolves them, and if we pour the alkaline solution upon them we obtain the same color, or we may substitute chlorate of potassa for the nitrate, the objection to the use of this however will be found in its tendency to explode when coming in contact with the acid.

This color, however produced, is not permanent but will slowly disappear with a rapidity proportioned to the amount of substance taken, but it will always appear with great distinctness when first adding the alkaline solution if any picrotoxine is present.

It is extremely probable that this color is produced from a trace of some nitrogenous body which pertinaciously adheres to the picrotoxine, as, on analysis, traces of nitrogen can be detected; but this body powerfully resists all attempts at separation, for when repeatedly crystallized the picrotoxine still retains a minute portion of it. It can be obtained perfectly free from nitrogen only by dissolving it in potassa and precipitating it by acids. When thus prepared its properties are the same as before with the exception of the purple color produced by oxydation and subsequent treatment with alkalies.

There is no substance at present known to the writer which gives this shade of color under these circumstances. There are two however which communicate a brownish-yellow to the fluid, and would, if present as an impurity, interfere with the distinctness of the reaction, these are sugar and strychnia; from the first we need suffer no inconvenience as it is perfectly separated in the ordinary method used for isolating the alkaloids; from the latter, picrotoxine is most completely removed by treating an acidulated aqueous solution of the two bodies with ether, the strychnia remaining as a salt dissolved in the water and the ether containing all, or nearly all, of the picrotoxine. To prove this the following experiment was tried. A quart of ordinary ale was divided into equal portions; into one ·045 gram. of picrotoxine and a little strychnia were introduced, the other was unadulterated; both were acidulated with hydrochloric acid, and agitated with ether; the ethereal solutions on evaporation yielded, in the first case, small microscopic crystals of picrotoxine mixed with a little extractive matter perfectly free from strychnine; the other yielded extractive matter alone. The test of sulphuric acid and nitrate of potash was then applied; the brownish-red color was produced in the first case, in the second there was no change. To ascertain the readiness with which minute quantities of picrotoxine can be detected $\frac{1}{5\,0}$ of a gramme of it was dissolved in a pint of ale; this was acidulated and treated as above; the ethereal extract furnished ample proof of the poison when tested.

In another experiment the stomach of a cat which had been poisoned was emptied of its contents so that only the picrotoxine absorbed by the coats of the stomach might be extracted. It was treated with alcohol and the solution evaporated to dryness. Acidulated water being poured on the residue, the picrotoxine and a little organic matter were dissolved; being now treated with ether and the solution evaporated, small crystals of picrotoxine were obtained, which, when tested, produced the characteristic red color. A portion of animal matter free from poison treated in the same way gave no discoloration.

In examining a liquid for picrotoxine it should first be rendered acid then shaken with ether; the residue left on evaporation of

the ether examined with the microscope for small prismatic crystals; if a few drops of sulphuric acid diluted with its volume of water are added in the cold and there are alkaloids present, they will dissolve, only so much picrotoxine passing into solution as is due to the water present, about one part for one hundred and fifty of water. A few drops of an alkaline fluid will dissolve the crystals and on applying heat the fluid will become first yellow and when more strongly heated will become brick-red. A small portion ground in a watch-glass with nitrate of potassa and sulphuric acid gives a solution which when rendered alkaline by potash or soda becomes a bright-red.

University of Michigan, Ann Arbor, March 26th, 1862.

ART. XIV.—*Some contributions to a knowledge of the constitution of the Copper Range of Lake Superior;* by C. P. WILLIAMS, A.M. and J. F. BLANDY, M. and C.E.

THE enterprise and vigor with which the *exploitations* of the Portage Lake District of the Copper region of Lake Superior have been carried on within the last few years, have developed many facts of great interest and importance in the constitution and structure of the Trap range of that place, beyond what have been made public through the medium of the excellent work, "The Metallic Wealth of the U. S.," by J. D. Whitney, Esq., and the reports of the geologists having in charge the examinations of the Lake Superior mineral districts.

The Trap range at Portage Lake has a width, as far as known, of about three miles, and is made up of a series of compact, granular, amygdaloidal traps, with occasional intercalations of sandstones and conglomerates, the whole having a strike of N. 32° E. and S. 32° W., with a dip of from 16° to 75° N.W.—the highest angle of dip being near the southeastern boundary of the range, while towards the northwestern limit, the rocks become more and more horizontal, until, finally, the sandstone which succeeds it becomes absolutely so.

Coincident, both in course and dip, with the rocks of the range are the so-called lodes of the district, which present no features of fissure veins, but are simply beds of highly amygdaloidal trap, carrying throughout their whole width—from 6 to 40 feet—small masses and grains of native copper, with a small amount of native silver, the cavities of the rock being large and filled with calcareous spar, quartz, chlorite, and several minerals of the zeolite family.

Several of the intercalated beds of sandstone and conglomerate also contain minute particles of copper, but none of these as yet

opened have shown an amount of this metal sufficient to warrant exploitation. However, on account of the very great extent linearly to which these beds are developed over the country, their persistence in thickness, and their well marked and constant characters, they become a valuable guide in explorations, and a convenient reference in the location of the various metalliferous deposits.

On a closer examination of the trappean range at Portage Lake it would appear to be divisible into certain zones, the rocks of which are bounded by the conglomerate and sandstone belts, and present features which characterize and separate them from the members of the other series. More especially is this observable in the copper-bearing amygdaloidal beds. The cupreous deposits of the several series differ so greatly in mineralogical composition that no difficulty exists in referring the materials from any one of them to its source, they being almost as well characterized as the vein-matter of the different districts of this mining region.

A complete section of the range at this point has not yet been obtained, as the explorations have not been extended to the extreme east and west boundaries of the trappean rocks. For a width of about two miles all the belts have been exposed, and the examinations have developed four distinct zones of rocks, which we shall name from the main metalliferous deposit in each. Passing from the east to the west these are: the Isle Royale, Pewabic, Hancock and the South Side series, or, as they are locally styled, formations.

Isle Royale Zone.—The rocks we shall include in this zone cover a width of about one and one half miles, and are limited on each side by belts of conglomerate. Within this distance, fourteen copper-bearing deposits have been opened at various times, all showing analogous features, though but two have as yet been systematically laid open to any great extent. They all have a very large amount of epidote, massive as well as crystalline, entering into their composition, and a comparative paucity of crystallized carbonate of lime. The other minerals in the constitution of the so-called lodes of this series, and usually denominated the vein-stones, are more crystalline in structure than the same species found in the other zones, but the abundance of the epidote it contains, and the almost total absence of this mineral in the neighboring zones, must be regarded as the main distinction. Another point of importance in its economical bearings, is the character of the copper produced from the mines in this zone, the proportion of the heavier description of copper being greater in this than in the other series.

Thus the Isle Royale lode yields in the following proportion: of mass and barrel (heavy) copper 60 per cent, stamp (fine) copper 40 per cent, whilst the great metalliferous deposit of the second series produces of mass and barrel copper 43 per cent, and of stamp copper 56 per cent. This comparison has been found to hold good through a series of years. All the intercalations of conglomerate opened in this zone, from its western to its eastern boundary, are cupriferous, and most of them have overlying them contact deposits of good width in which this metal has been concentrated, while not one bed of the sedimentary rocks found west of the conglomerate forming the western boundary of the zone, has been found to contain a trace of cupreous mineral.

Near the eastern limit of this zone several of the lodes have been found to contain a small amount of the sulphuretted ores, and a large amount of quartzose vein matter with arsenids of copper (whitneyite and domeykite) has been found in angular fragments on the surface in the same vicinity, pointing to the proximity of veins of an age and composition different to anything yet opened in the Portage Lake District, and most probable synchronous in formation and repletion with the veins mined in the Southern or Bohemian range of Point Keweenaw.

Pewabic Zone.—Resting on the rocks of the first named series, but separated from them by a copper-bearing conglomerate with its accompanying contact vein, and occupying a width of nearly 1300 feet, occurs the Pewabic zone. In this formation ten belts of metal-bearing amygdaloid have been opened, of which three only have been worked to any extent, and one of these, that from which the series has been named, has given wonderful results, having yielded about 600 lbs. of ingot copper to the cubic fathom. The rocks are characterized by the almost total absence of epidote, whilst those beds carrying copper have a large amount of calcareous spar and laumontite entering into their composition. No conglomerate intercalations occur in the space occupied by these rocks, though it is limited on the west by a belt of such rock of 40 feet thickness, which, though opened at several points, has shown no trace of copper. The character of the copper produced from the amygdaloid belts mined in this series has been alluded to in the description of the rocks of the Isle Royale zone. No traces of any sulphuretted or other ores of copper have been found in this series.

Hancock Zone.—The rocks comprised within this zone have a width of nearly 600 feet, being included between the western conglomerate of the Pewabic zone, upon which they rest, and another bed of the same rock of a width of about 45 feet. The rocks dip at an angle of nearly 45°, and are of a much softer character than anything noticed to the east of them, chlorite entering largely into the composition, and the entire formation

is much broken up and fissured by cross-courses at the places opened.

The metalliferous occurrences yet opened comprise three belts of amygdaloid trap, containing much chlorite, and about two per cent, or upwards of 600 lbs. of ingot copper to the cubic fathom. The conglomerate limiting the series on the west contains no copper.

South Side Zone.—We have given this name to the rocks resting on the Hancock formation from the fact that their characters have been almost entirely developed by the explorations on the lands of the South Side Mining Company. These rocks comprise a width of over 2100 feet, and are made up of frequent alternations of porous and highly amygdaloidal traps, with belts of sandstone and conglomerates, for a distance of nearly 1000 feet, the balance being almost entirely sandstone and conglomerate, with an occasional intercalation of a porous trap bed. This zone appears to be almost entirely destitute of metalliferous occurrences. Beyond its limits the few explorations made show the rocks to be entirely sandstone, with a constantly decreasing angle of dip, as the igneous rocks are receeded from, till at a distance of two miles it is found in horizontal layers.

The base of the range, as developed at the southeast limit at Portage Lake, is a fissile chlorite rock, the same as forms the basis of the Bohemian or Sulphuret Range at Point Keweenaw. This has elevated the bed of trap which rests on it to the northwest, and the sandstone which lays on it to the southeast, to a considerable angle, amounting, in the case of the trappean rocks, to 75°, but which we have shown becomes gradually less in the northwestern development of these rocks. The decrease in the angle of dip of the sandstone at the southeast is much more rapid than that of the trappean rocks and sandstones, and at a distance of three quarters of a mile from this line of elevation is found again in a horizontal position.

The occurrence of this chlorite rock in proximity to those beds of rock which form the base of the Isle Royale series, and contain sulphids and arsenids of copper, would appear to point to the identity of the rocks of this zone with those forming the southern limit of the greenstone or north range, and the northern boundary of the southern or Bohemian range of Keweenaw Point. This view is further strengthened by some examinations recently made by Samuel W. Hill, Esq., in that region where that gentleman found an extensive series of trappean beds, highly epidotic in composition, and carrying native copper, intercalated with other beds containing the ores of that metal. There are doubtless many rocks occurring in the Bohemian Range, in the vicinity of Lac la Belle, porphyritic in character, which are not developed in the Portage Lake District, but this does not affect

the question of the identity of the rocks of the eastern portion of the Isle Royale series with some of those known to occur in the Sulphuret range, since instances of the thining out of belts of trap have been observed and well proven by explorations at Portage Lake, as well as elsewhere. The Isle Royale series of rocks widens out northeasterly from Portage Lake towards Point Keweenaw. The Pewabic series widens out towards the northeast, and thins out southwesterly at the rate of over sixty feet to the mile; and the Hancock zone also becomes wider towards Point Keweenaw, but the rate of increase is much less than in the case of the Pewabic rocks—amounting to but about fifteen feet in the mile.

In the Keweenaw Point District it has been shown by recent researches that the series of rocks in which the Cliff vein has been found most highly productive, recedes from the greenstone in its easterly prolongation, other belts of compact and amygdaloid traps being introduced between the crystalline belt and that series, the rate of increase being in all probability much greater than anything noticed above.

Towards the Ontonagon District the trap range again widens out, and at its southern boundary we find a series of ridges made up of rocks analogous in structure and identical in mineralogical composition with the belts found making up the Isle Royale zone. The mineral accumulations here are also in the form of segregated deposits, called "epidote lodes"—that mineral entering largely into their composition. The so-called veinstone is of such appearance as to be readily confounded, even by the experienced eye, with matter from the Isle Royale lode at Portage Lake.

Traces of the sulphids of copper have been found in this region also, on the southern limit of the United States location, as well as elsewhere. The course of these rocks is through the Evergreen Bluff, Peninsula, Forest, United States and Ohio Trap Rock locations.

Thus, from the end of Point Keweenaw to a very considerable distance beyond Portage Lake the rocks which we have classified as belonging to the Isle Royale series, appear to exist at or near the base of the Trap Range of Lake Superior, but in the western prolongation of the Range, towards the Wisconsin boundary line, another series becomes developed, as is shown by the works at the Norwich mine, but little is known of the relation or composition of these rocks. However, a bed of fissile chlorite rock which we have reason to suppose is identical with the rock we have described at the base of the range at Portage Lake, has been opened at the southern limit of this series of rocks, and is shown at the mouth of the adit of the Windsor mine.

From the above it is obvious that though many of the belts of rock of the Range are persistent throughout its whole length, yet the absolute contact of all the zones we have pointed out should not be too rigidly expected over the whole distance, since other belts or series of belts may be introduced between them.

Veins of the Lake Superior Region.—Three classes of metalliferous occurrences have been shown to exist in the Trap Range: Fissure veins, Segregated and Compact deposits.

Fissure Veins.—This class of veins are almost entirely developed on Point Keweenaw. In their course they may be traced across the whole width of the mineral formation, from the Bohemian or South Range to the north shore of the Point, cutting the sedimentary beds without a deviation of course, and even breaking through the pebbles of the conglomerate. They generally show small displacements of the beds, both horizontally and vertically, although there are some marked exceptional examples. The largest '*heave*' yet noticed is that at the Humboldt mine, near Eagle River, where the "Ash bed"* is found on the east side of the fissure vein, about 350 feet north of its position on the west side.

The course of these veins varies from N. 16° E. to N. 58° W., the average of the seventeen principal ones now worked being N. 18° W. They are nearly perpendicular, with a slight underlay to the east.

Evidences of the existence of a later and distinct line of fracture are to be found, the course of which was E. of N. about 15°, and which has given rise to some powerful, though not highly productive veins, which displace considerably the formation as well as the veins of the first class. At the North American mine the Cliff vein is *heaved* 250 to 300 feet by the Armstrong vein, which is necessarily posterior in formation. The existence on Keweenaw Point of still another line of fracture, with a general course of N. 65° E. has been contended for by some, but the evidences are more from the topographical features than from any direct explorations or exploitations. Certain it is, however, that one member of this system has been opened in the Portage Lake District, but presented no features to warrant any further examination, so that nothing is known of its composition and structure. Still another has been traced for a length of 1200 feet on the Columbian location. In the same district a vein belonging to the second system was mined for some time on the Quincy property, but did not prove of remarkable richness.

* A segregated deposit situated north of the greenstone axis of Point Keweenaw, and yielding 1·2 per cent ingot copper. It has been extensively mined at the Copper Falls, Phœnix and Garden City locations, and has been traced for 12 miles over the country.

In the Ontonagon region but few fissure veins have been opened, and most of these have a course of from 60° to 70° east of north, varying about 30° from the bearing of the formation, with a dip of from 50° to 60° to the north. An exceptional instance is found in the one vein opened on the Douglass Houghton property, which was transverse to the line of bedding of the trap, and is necessarily of different origin.

On account of the variation of the meridional course, as well as the direction in comparison with the bearing of the beds of rock, it is difficult properly to classify the fissure veins of the different districts. An examination of them in connection with the topographical features of the country would seem to point to various causes of occurrence, arising from the method of elevation of the trappean range. The curvature of the range on Keweenaw Point around the centre of elevation of the South or Bohemian Range, would appear to account for the *radial* fractures, embracing nearly all the veins of the first class, the course of the veins changing from E. of N. at the east end of the Point, to N. 58° W., at the North American Mine, at the west end of the curvature. Variations from the general rule of radial fracture occur, but it is a question whether these cannot be accounted for by local causes, or whether they are not fractures between the main veins.

From the North American Mine to a few miles southwest of Portage Lake the Range holds a very direct course, showing no conspicuous elevations, and the topography of the country denotes no disturbances in the formation with the exception of the deep gorge of Portage Lake. In this section no fissure veins of the first class have yet been found.

The fissure veins of the first class in the Ontonagon District seem to be due to the warped position in which the elevating forces have left the strata. The range is broken by many deep gorges, marked by the passage of the rivers. The best example we have of the warped position is in the division of the range between the Flint Steel, and the Ontonagon Rivers, the dip of the rocks at the east end or in the Flint Steel mine being 33° and gradually rising to about 57° at the National mine near the west end. The small number of fissure veins which have been opened in this district, and the limited extent of the workings upon them will hardly justify any positive assumption with regard to their origin; we would however instance the North vein of the Minnesota mine as being probably an excellent example, and one which may be found repeated in other sections of the same district. The course of this vein is 60° E. of N. cutting the strike of the strata at its intersection with the conglomerate bed at a small angle, the angle of intersection being open towards the east. Direct experiments with plastic sub-

stances in layers raised in a position to form a warped surface, similar to the one referred to, have been made to show that fractures would be formed in exactly the same manner as those existing at this locality. In the process of elevation it would be natural to suppose that the greatest amount of lateral motion would take place along the surfaces of the sedimentary beds, for the reason of their lesser adhesion, and besides that they present a comparatively smooth surface, whereas the surfaces of the trap beds are rough and irregular as shown in the amygaloidal beds, which have been mined. It is also to be supposed that the length of these veins will be found comparatively short, and would show a displacement at the intersection of other sedimentary beds.

The veins of the second and third class are mostly known in the Portage Lake District. These may be due to a second elevation of the mineral range, evidences of which, we see in the position of the terrraces on the shores of Portage Lake. These on the north side of the lake are higher above the present surface of the water than on the south side, besides which, instead of being horizontal, present a very decided ascent towards the east. On the south shore this ascent is very perceptible and also the change in grade, which takes place on the Sheldon location; from that point it being steeper towards the east than the descent towards the west.

The large veins of the third class, having a course of 60° to 70° E. of it—known in the mines as cross courses,—are most probably the effects of the force causing the depression of the range forming the deep gorge of Portage Lake. This view is well supported by the results obtained in exploring at the Dacotah location on the south side of the Lake for the Pewabic lode, the openings on which have been entirely confined to the north shore. On running its course and making calculations for the differences in level,—on account of the dip of the lode,—between the two shores the lode was found to be at a point 1300 feet east of the continuation of its direct course as pointed out by the surveyor, the distance between the two points being about one half a mile and nearly the whole being occupied by the gorge of Portage Lake. No prominent veins of this class have been found in this district, except on the hill sides bounding the Lake. Veins of the same class may yet be discovered at a greater distance from the lake although not necessarily parallel with the ones now found.

Segregated Veins.—The class of segregated veins has, within the past five or six years, attracted the most attention from the mining companies on account of the facilities they offer for economical mining. They are as before stated simply beds of cupriferous amygdaloid coincident in strike and dip with the

formation. In all the three districts they have been opened and have shown a wonderfully uniform degree of richness, the amount of copper being about 1·5 per cent of the whole mass. They vary in width from six to forty feet and are consequently to be mined with more economy than the narrow fissure veins, moreover, the comparatively uniform distribution of the metal renders their working less precarious than that of the transverse veins in which rich and poor ground alternate quite frequently. A decrease in the yield of these deposits in depth is contended for by some, whilst others tenaciously hold to an increase in richness. The data accumulated however in regard to this question are too few, as yet, for any one to venture upon pronouncing dogmatically with reference to either side.

Contact Veins.—Of the contact veins the examples mined are few, though several have been opened in the various districts. All of them are invariably super-imposed on the conglomerate and overlaid by a belt of trap. The sedimentary belt is always more or less impregnated with copper, and oftentimes the belt of amygdaloid which is subordinate to it contains a small amount of metal. The average yield of ingot copper cannot be definitely given except in the case of one of them—"the Minnesota conglomerate lode"—in which the amount can be set down at about two per cent of the whole mass. The richness of these deposits is remarkably variable in the direction of the lode as well as in its depth, though in the latter, in the case above cited, the yield is steadily diminishing and the proportion of stamp copper to the mass copper becoming sensibly greater.

Houghton, Portage Lakes, Michigan, 1862.

ART. XV.—*Correspondence of Jerome Nicklès, dated Nancy, France, May 6, 1862.*

Obituary.—T. B. BIOT, born April 21st, 1774, died Feb. 3d, 1862, aged 88 years. From early youth he exhibited scientific talents of a high order. He was in 1794 a member of the first class graduated at the Polytechnic School founded by the French Republic, from which he went forth in 1795 to enter upon the work of public instruction. In 1800 he was appointed Professor at the College of France, a position which he occupied until his death. In 1803 he was elected a member of the Academy of Science at Paris, where he took the place of Delambre as perpetual Secretary and he has been connected with that body over 59 years. He was one of the editors of the *Journal des Savants*, and from 1805 was connected with the Bureau of Longitude. He died of a pulmonary affection which terminated in inflammation of the lungs. He was, in the Academy, the last representative of that heroic epoch, which at the close

of the last century and the commencement of the present saw an immense revolution accomplished in the physical sciences as well as in the institutions of France. A pupil of Laplace, of whom he became an ardent friend, he took part in the celebrated Society of Arcueil which that philosopher had founded in concert with Berthollet, the other members of which were Gay Lussac, Thénard, Humboldt, DeCandolle, Collet Descotils, Malus, Arago, Chaptal, Dulong, and Poisson. Of this illustrious phalanx, M. Biot only remained, and it is certainly not without emotion that we see the eclipse of the last of these illustrious men who have rendered such great services to science.

Biot was not merely a great mathematician, he took a deep interest in all branches of scientific observation. At the commencement of the present century (1804) he made a balloon ascension, with Gay Lussac, which is still celebrated. With Arago he extended the measurement of the arc of the meridian begun by Mechain in France to Barcelona in Spain, and to the Balearic Isles, and at a later day in connection with the English savans he continued this measurement to the Orkney Isles. He made researches, still celebrated, upon the *refraction of gases*, and he found means of enriching science with new discoveries in regard to the properties of light, after Malus, Fresnel, Young and Arago had so remarkably enriched the science of optics, that they had been classed with Descartes, Newton, and Huyghens. Among others may be mentioned the efforts he so long continued to apply circular polarization to chemical researches, and he had the happiness to live to see his efforts crowned with success.

We owe it to Biot that aerolites are no longer treated as chimeras. Until 1803 it was not believed that stones really fell from the heavens; on the occasion of a fall of aerolites which took place April 26th of that year at L'Aigle (department of Orne, Normandie,) he established the fact and showed that the stones must have come from a source beyond the earth. In 1809 he was appointed Professor of Physical Astronomy in the Faculty of Sciences at Paris, with which he remained associated as honorary professor until his death. It was while he occupied this chair that he reëdited his "*Traité Elèmentaire d'Astronomie Physique*," composed in 1805, and of which the third edition appeared in 1850 in six volumes. This together with the *Traité d'Géométrie Analytique*, 1802; the *Physique Expérimentale*, 1806, 4 volumes, and his *Précis de Physique*, 1817, 2 volumes, are his most elaborate works.

Biot was not only a great geometer and a distinguished physicist, he was also a profound scholar and a writer of the first order. He belonged to three of the Classes of the Institute, viz., the French Academy, the Academy of Inscriptions and Belles Lettres, and the Academy of Sciences, a distinction enjoyed by none other. Among his varied labors he made numerous researches in Chinese and Egyptian astronomy, and he inspired his son Edward Biot, who died ten years since, with a taste for the same studies.

The last work of M. Biot is entitled "*Histoire de l'Astronomie Chinois*," which he communicated orally to the Academy in November last. Biot never sought any political position; his sole civic function was limited to being Mayor of the small village of Nointel (in the department of the Oise) where he owned a country seat. All his time was consecrated to

literature and science. He was very kindly disposed towards young men, especially to those physicists and chemists who labored in his own favorite studies. For such as these he ventured all, and zealously protected them. It is well known how much abuse this kindness called forth, so that some physicists and chemists who had a sense of their own dignity, for a long time refrained from publishing their researches upon rotary polarization applied to the detection of chemical substances, for fear of being regarded as devoted to the science only for the purpose of securing the favor and patronage of a powerful man. Such cases were not, however, very numerous; far greater was the number of these professions whom Biot patronized and who justly deserved this favor, of whom the illustrious acoustician, Savart, may serve as an example. We have previously noticed (this Jour. [2], xvii, p. 294) his benevolence to the chemist Laurent.*

Isidore Geoffroy St. Hilaire: The founder of the "*Société Zoologique d'Acclimatation*," &c.—The eminent Zoologist who has rendered such great service to science died on the morning of the 10th of November last. He was the son of Etienne Geoffroy St. Hilaire. Among his ancestors were two chemists known in history as the two Geoffroys who made their mark upon the science of their age. The example and instruction of his father early inspired Isidore Geoffroy St. Hilaire with a taste for the natural sciences, to the study of which he devoted himself with an ardor which was crowned with precocious success. He was born in 1805 and in 1826 he presented to the Academy of Sciences a memoir upon mammifers. He was only twenty-seven when he was elected to the place vacated by Latrielle as member of the Academy of Sciences of which his father Etienne Geoffroy was president. Some time later he was appointed Professor of Zoology in the Faculty of Science at Bordeaux, afterwards he became Professor of Zoology at the Museum, Director of the Menagerie which had been established by his father, and at length Professor of Zoology in the Faculty of Sciences at Paris. Doubtless he was much indebted to the patronage and reputation of his father, yet he made great and successful efforts to sustain the honor of his name and to justify his rapid advancement as an instructor in the University. As a zoologist he devoted himself first of all to extending and developing the great ideas put forth by his father. He was also engaged in making practical applications of zoology by multiplying the species of animals useful to man for food, clothing, and labor. It was this purpose which led him to found the "*Société Zoologique d'Acclimatation*" which has already proved so useful and which extends its influence not only in France but throughout Europe and even to all parts of the world as has been often mentioned in my former correspondence.

In 1836 he delivered at the Museum, a course of "*Leçons de Tératologie*," which were reported and published in one volume octavo by Victor Meunier, a young man of great promise whom Etienne Geoffroy had taken into close friendship. The same year he delivered a course of "*Leçons de Mammologie*," which were reported by Paul Gervais. His "*Leçons de Zoologie Générale*" were published in 1848. He also pub-

* We have received an advance copy of an able and discriminating notice of Biot, from the learned Secretary of the American Academy of Sciences at Boston, for which we have not space in this number.—Eds.

lished from 1832 to 1836 "*Traité de Tératologie*," 3 vols. in 8vo, with plates—"*Essai de Zoologie Générale* ou *Mémoires sur le Zoologie Générale l'Anthropologie et l'Histoire de la Science*, in 8vo. 1840."—"*Historie Naturelle des Insects et des Mollusques*," 1841. 2 vols. 12mo, with figures.—"*Vie, Travaux, et Doctrine Scientifique, d'Etienne Geoffroy St. Hilaire*," 1847, in 8vo.—"*Catalogue Méthodique du Museum d'Histoire Naturelle*," 1851, in 8vo.—"*Domestication et Naturalization des Animaux Utiles*," 1854.—"*Histoire Naturelle Générale des Règnes Organique, Principalement chez l'Homme*." 1854–1857. 5 vols. in 8vo. Besides these works there are many memoirs scattered through the *Comptes Rendus*, the *Annales des Sciences Naturelles*, the *Bulletin de la Société Zoologique d'Acclimatation*, &c.

From this it is easy to see that Isidore Geoffroy St. Hilaire deserves an honorable place in the annals of science, although his services are less appreciated because they have not equalled those of his father. But from what we have enumerated it is evident that he had sufficient knowledge, enterprise and zeal to make his way for himself. It was obvious to all who met him that fortune had loaded Isidore Geoffroy with favors without drying up his sympathies or rendering him egotistical. He sympathized with all sufferers and interested himself especially for those men of science whom fortune little favored nor did he wait for the rich or powerful to patronize them before he became interested for them.

In 1854 he was president of the Academy of Sciences, before which time he had no acquaintance with the chemist Laurent whom he knew only by reputation. It was sufficient for him to learn the precarious situation of the widow and children of the chemist to induce him to go at once to Madame Laurent and place at her disposal all the influence of his name and position as president of the Academy of Sciences. We can say of him as we said of Biot, that he was a member of the principal learned societies of the world.

Acclimation.—We cannot better conclude the obituary of Isidore Geoffroy St. Hilaire than by noticing the one great work of his life, the "*Société Zoologique d'Acclimatation*," the success of which is becoming more and more remarkable, thanks on the one hand to its organization and on the other to the zeal and the talents of the men who composed it, and who, like Messrs. Richard (of Cantal)* and Guerin Meneville, devoted themselves to natural history from the love of it, having made great progress in such studies long before the establishment of the Society of Acclimatation.

Disease of Silkworms.—Coincident with the formation of this Society in 1854, was the appearance of a scourge which has several times threatened to destroy one of the great industries of France, the silk culture, which alone yields 300,000,000 francs per annum. The silk manufactured in France is not all produced in the country. The silkworm ordinarily produces about 150,000,000 francs of raw silk besides which we import about 60,000,000 francs value more. This silk after being manufactured at Lyons, Nismes, St. Etienne, &c., acquires a value of more than 310,000,000 of francs. The disease of the silkworm becomes therefore to these manufacturing centres a perfect scourge; hence from its very

* This Journal, [2], xxviii, p. 431.

origin the Society of Acclimation has undertaken to examine the cause of this disease among the silkworms. In this investigation the Society has been ably seconded by M. Guerin Méneville who had made these insects a special study. Not only have they made a thorough study of the *Muscardine* and other diseases of the silkworm, but they sought also to acclimate other silkworms, particularly the species which feeds upon other leaves than those of the mulberry. The following *résumé* of those experiments we find reported in the Bulletin of the Society. "From these researches it appears that the disease of the silkworm is caused principally by a disease of the mulberry trees, on the leaves of which the silkworm is fed. This disease can be cured by placing the infected eggs for some time in a box containing a little spirits of turpentine. But this treatment does not prevent the reappearance of the disease upon the worms when they are fed upon the leaves of diseased mulberry trees."

In reference to the introduction of new species of silkworms, we have mentioned in previous correspondence the *Bombyx cynthia*, a silkworm which feeds upon the *Ailanthus glandulosa*. More than two thousand amateurs are this year engaged in efforts to rear this worm which feeds freely upon the Ailanthus trees; these experiments have not all resulted satisfactorily, the insect-eating birds have made a war of extermination upon the *Bombyx cynthia*. Nevertheless the degree of success is so great that, according to M. Guérin, it is now practicable to carry on with some success experiments on a large scale.

But the principal difficulty connected with this manufacture arises from the difficulty of separating [reeling] the silk from cocoons of the *Bombyx cynthia*. This difficulty has at length been overcome by two different methods, one of which was discovered by Madame Vernède of Corneillan, the other by Dr. Forgemol.

The culture of the silkworm which feeds npon the Ricinus (Castor Oil Bean) ought to be abandoned in France on account of the climate. This industry flourishes only in warm countries where the Ricinus does not freeze in winter; after experiments tried upon an extended scale the culture of this silkworm has proved successful in the Canary Islands.

While experiments are continued upon a mixed breed between the silkworm of the Ricinus and that which feeds upon the Ailanthus, on the other hand, experiments are in progress with the silkworm which feeds upon the oak, also upon the *Bombyx hesperus* in an experiment at Cayenne where Michlez sought to introduce the culture of silk.

This Bombyx does not succeed in France because it hatches at a season of the year when all vegetation is arrested. The plant upon which this silkworm feeds in the natural state, bears the name of *café diable*. Michlez discovered that the Ailanthus suited it still better, and that it developed itself perfectly upon this tree. In a package of silkworm eggs sent to the Society of Acclimation by the French Consul in Japan, (M. Duchesne de Bellecourt) Guérin Mèneville found a new kind of silkworm. This species, known in Japan under the name of *yama-maï*, feeds upon the oak. The silk which it produces is of a very beautiful quality. It is more solid and more beautiful than that of other species of silkworm which feed upon the oak.

Astronomy.—Reconstruction of the Bureau of Longitude.—For a long time there has existed among astronomers in Paris a strife quite unworthy of the science, in which personal rivalries are much more prominent than the progress of astronomy which has gained nothing by the unhappy scenes of which the Academy of Sciences has been for a long time the theatre, and which have been of no benefit even to those who have systematically undertaken to disparage all the scientific labors of the most able astronomer among them, the Director of the Observatory. The work of the Bureau of Longitude having suffered very much by these internal dissensions, this body has been reconstructed, retaining all who have heretofore been members, and adding some new names from among the contestants. The class of assistant members is suppressed and all the members are made equals. The Bureau as now constituted comprises

3 Members of the Academy of Sciences, viz:—Liouville, Le Verrier and Delaunay,

5 Astronomers, viz:—Messrs. Mathieu, Laugier, Yvon de Villarceau, Faye and Foucault.

3 Members from the Navy, viz:—Admirals Mathieu, Deloffre, and Nn. . .

1 Member belonging to the War Department, Maréshal Vaillant.

1 Geographer, Colonel Peytié, with the rank of Major.

3 Artists, Messrs. Bréguet, Lerebours and Brunner.

It has been organized by the appointment of, for President, Maréshal Vaillant; Vice-President, Admiral Deloffre; Secretary, Villarceau.

New Observatories.—The Observatory at Paris is about to establish a branch in the south of France, in order to have the advantage of a purer sky than that on the borders of the Seine. The necessity of this was more than ever realized in the recent efforts made to recognize the Satellite of Sirius lately discovered by Mr. Clark. It was only after repeated efforts and with a sky for a few moments unusally pure that M. Chacornac was able to verify the discovery of Mr. Clark. Since then clouds have rendered it impossible to see the companion of Sirius again at Paris.

Astronomers appear to be more than ever engaged in searching for a pure sky. M. Bulard, the Director of the Observatory of Algiers has found a sky of remarkable transparency in the oasis of Laghouat which is situated exactly in the meridian of Paris. They will not fail to found an observatory in that beautiful country when it becomes more accessible. Already Russia has taken a similar step by establishing an observatory on Mount Ararat.

International College.—For some time there has been a project considered which will be laid open for *concours* through the medium of the Universal Exposition of London. It relates to the establisment of an International College to be organized simultaneously at Paris, Oxford, Munich, and Rome or Florence.

The principal of this unique College is to establish in the four countries an identical course of study to be conducted simultaneously in four different languages so that the students may at any time change] their residence and language without any modification of the method or course of study. The initiative of this measure has been taken by M. Barbier, a manufacturer of Clermont-ferrand. In order that this question may

receive the consideration which it merits, M. Barbier has laid it open for *concours* accompanied with the sum of 5,000 francs. A commission chosen by the Jury of the Exposition of 1862 will give its advice upon the classification in the order of their merits of the memoirs which may be presented upon the subject by different competitors.

These memoirs written or translated into French are to be delivered before the 31st of May 1862 at Paris at the Palace of Industry, or at London at the hotel of the Imperial Commission. The authors of the four memoirs classed in the first rank will receive prizes of 2000, 1500, 1000, and 500 francs respectively.

This *concours* has created some sensation and it is hoped that it will be followed by useful results. It should be remembered that in 1855 the project of an international college engaged the attention of Fortoul the Minister of Public Instruction whose sudden death in 1856 delayed the progress of the enterprise. His attention had been directed to this subject by Eugène Rendu, the Inspector General of the University. A complete programme of studies was proposed for this project which has for a considerable time been executed though imperfectly in several countries. Thus there is at Paris an Egyptian school supported by the Viceroy of Egypt which receives only Egyptians, at Athens a French School supported by the French government where only young French literati are received, &c. Thus we see that the idea of Rendu and Barbier existed previously although only in the germ.

Manufacture of Aluminium.—We have repeatedly mentioned to our readers the progress of the manufacture of Aluminium since St. Claire Deville discovered the method of obtaining it on a commercial scale. They have learned to forge aluminium, to file, roll, punch and to engrave it with any design the workman may select. The method of drawing it into fine wire has remained hitherto an unsolved problem, though not for the want of diligent efforts to accomplish it. The superintendents of the two manufactories of aluminium ingots, comprehending the importance of being able to draw this metal into fine wire have made great sacrifices to resolve the problem. They have applied to the manufacturers of gold wire both at Paris and at Lyons, but all their efforts have failed. The aluminium has so little density that its texture is at once broken up and it becomes as friable as glass, so that it leaves upon the draw-plate the superficial molecules which are in contact with the instrument.

The problem of drawing aluminium into wire has however just been resolved by M. Garapon, an artisan of Paris who now conducts the operation in a truly workmanlike manner. He furnishes the aluminium wire at from 60 to 100 per cent cheaper than silver wire of the same length. The price of aluminium is always about 200 francs per kilogram. For the purpose of drawing it into wire they commence with rods of aluminium of one metre in length and 12 millemetres diameter, these the inventor easily reduces to wires of the size of a hair and many hundred kilometres in length. These products appear in the London Exposition, where are seen articles of lace work, such as epaulettes, embroideries, textile fabrics, entire head-dresses, with mounting and ornaments constructed entirely of aluminium. These articles are remarkable for their lightness, and they show that a novel manufacture has been created by the

new process of drawing aluminium into very fine wire. For the details we must await the results of the London Exposition.

Culture of Cotton.—The planting of cotton in the differnt French and English colonies has made considerable progress; it would succeed still better in France if the French were accustomed to act for themselves, without the aid of the government. The culture of cotton in Algeria in the vicinity of Mortaganem has received a great impetus from the establishment of an English company in that country so favorable to the growth of cotton. Other experiments have been made in Senegal by both the French and the English. In India already a million kilograms of this textile material have been collected, and the present year the product will be doubled. At the present time an effort is in progress to take advantage of the favorable climate and soil of French Guyana to introduce the culture of cotton on a grand scale. This plant was cultivated there a long time since, but the culture having been badly managed it was for a time abandoned.

The question has arisen of reopening the culture in that region. Two reasons principally determine the resumption; first cotton succeeds there remarkably well and it is of excellent quality, secondly there are found there, what is wanting in other climates, plenty of laborers. Besides the small proprietors who live there, and who ask for nothing more than some lucrative culture, there is the penitentiary occupied by 10,000 or 12,000 convicts who are already accustomed to toil, and who have recently performed well the work of clearing the land.

On all sides then there is an effort to provide against the crisis which more and more menaces the manufacture of textile fabrics. With the cotton which Egypt already produces, and which she will be more and more interested to produce, especially in the vicinity of the Isthmus of Suez, with that which is obtained in India and Algeria, with the plantations which are made or increased in Senegal, Soudan and Cambodia, and lastly in Guyana, European industry hopes to free itself completely from the tribute which it has hitherto paid to the United States for cotton.

Scientific News.—We here place on record certain scientific facts of some importance which have recently transpired. Among these are (1) The discovery by M. Lamé of the existence of a thrid and non-luminous ray in double refracting media. (2) The production by Berthelot of the hydrocarbon C^2H, (acetyline) by synthesis, by making a current of hydrogen pass over charcoal rendered incandescent by the electric current. (3) The transformation of aldehyd into alcohol effected by Wurtz by means of amalgam of sodium. (4) The magnificent researches of Hofmann upon the derivatives of aniline, those beautiful colors which have for some years produced such a sensation in industry which no one has yet been able to obtain in a state of purity, and which Hoffmann has reduced to two types, rosaline and leucaniline, which bear to each other the same relation as white indigo and blue indigo. (5) The treatment and cure of obstinate ulcers by (solid) carbonic acid which is the most powerful cicatrizing agent known. (6) The construction of a telescope with a silver mirror of 80 centimetres (=31½ inches) diameter and with a focal length of 4·5 metres (=17¾ feet) by Foucault. (7) A new system of railways

called "*Chemin de Fer Glissant*" (sliding railways) by M. Girard. In this system there are neither wheels nor axles; the carriages are true sledges sliding upon hollow runners moving upon rails sufficiently large. The runners contain water under pressure, which is designed to raise them, and by seeking to escape from all parts to prevent all friction of metal upon metal. Girard makes his experiments at the expense of the Emperor of the French. This railway system moves upon a road 40 metres in length, and for one on this scale the results are already very satisfactory.

Bibliography.

The following works have been published by HACHETTE, *rue* Pierre Sarrazin, Paris:

J. Nicklès.—"*Relations d'Isomorphism qui Existent entre Les Métaux des Groupe de l'Azote*," 1862. The fundamental conclusion of this work is that bismuth ought to be hereafter arranged in the nitrogen family with phosphorus, arsenic and antimony. The author shows this by new facts drawn from chemistry and crystallography. Thus the composition and the crystaline form of I^3As, I^3Sb, I^3Bi, also the combination that these iodids or the corresponding bromids give with alkaline chlorids, bromids or iodids; he describes a great number of new combinations, distributed in isomorphous groups; the more interesting are those containing at once both bismuth and antimony replacing each other isomorphically.

L. Figuier.—"*L'Année Scientifique Industrielle*," 6th year, 1862. Every scientific movement which has taken place during the year 1861, is related in this little work which is devoted principally to the practical application of scientific facts. The work is in its sixth year and its success is already assured.

Zeller.—"*Année Historique*," II.—This periodical takes the place in reference to history that the Année Scientifique holds in reference to the applied sciences. It is an annual review of the questions and political events of the principal states of the whole world. Its author, M. Zeller, is the Professor of History at the Normal School of Paris and finds himself by position as well as from preference profoundly versed in those subjects which he treats in this review.

Pietra Santa.—"*Chemins de Fer et Santé Publique.*" 1861, 12mo. This work devoted chiefly to the hygiene of travellers by railways and also that of employées (upon railways) draws the conclusion that:—Railroads exercise a happy influence upon health. He examines carefully all that relates to this question; for example the *Daltonism* or *Pseudochromotopsy* (color-blindness), an affection which is attended with danger when it is a railway employée who is affected. The work closes with extensive bibliography of all which has been published upon the subject.

Jules Simon.—*L'Ouvriere*, in 12mo, 4th edition. 1862. This work of high moral and social position, is principally devoted to the different questions relating to operatives in modern workshops, especially those situated in France. Its author, one of the most independent and celebrated of living philosophers, has recorded in this little work the results of observations continued for many years in different manufacturing centres in France. There is not a manufacturing town which he has not visited with care, as well as the different organizations established to improve the condition of the laboring people.

M. Jules Simon gives the preference to the city manufacturers of Mulhouse, organized under the direction of the Industrial Society of this important manufacturing town.

Cournet.—*Traité de l'Enchainement des Indées dans les Sciences et dans l'Histoire.* 2 vols. 8vo. 1861. See this Jour., xxxi, 111.

Charles Roger Bacon: Sa Vie; *ses Ouvrages des Doctrines, d'Après des Textes Inédits.* 1 vol. 8vo. 1861. See this Jour. xxxiii, 110.

Quatrefages. Unité de l'Espéce Humaine. 1 vol. 12mo. 1861.—This work is a resumé of the lectures delivered by the author as Professor of Anthropology at the Museum of Paris. He has given an affirmative answer to this question, recently contested in view of the latest geological discoveries. (See correspondence in this Journal, [2], xxix, p. 269.)

Lecoq.—*La Vie des Fleurs.* 1 vol. 12mo. 1861.—We have frequently mentioned the valuable labors of Lecoq the Naturalist, Professor of Natural History to the Faculty of Sciences of Clermont, and a Correspondent of the Institute. This new

work is especially designed for the use of the masses. The vegetation of the entire globe is passed in review and considered in its relations both to men and animals, an easy task for Mr. Lecoq since he is at once a botanist, physiologist and geologist, and he is the one who has made known to the scientific world the central plateau of France, including the mountains of Auvergne.

Paul Marcoy.—Scènes et Paysages dans les Andes.—Eight years sojourn in the Cordilleras of the Andes has enabled Mr. Marcoy to study the manners of the inhabitants of those elevated regions. He visited the principal mountains and was the first to attempt the ascent of the *Urusayhua*. This daring traveller has published his adventures and observations in a style at once picturesque and entertaining.

Chez H. BOSSANGE, Librarie Quai Voltaire à PARIS.

A. Delesse.—Etudes sur le Métamorphisme des Roches. Large Quarto. 1861.—This work contains the important researches which we have formerly reported and which have been honorably noticed by the Academy of Science. Mr. Delesse has treated principally upon general or normal metamorphism. Considering the condition in which combustibles are arranged, as well as calcareous rocks, sandstones and clays, the author has studied their successive metamorphisms. They have for their extreme limit the *anthracite* or the *graphite*, the *white marble*, the quartz, the *mica-schist*, and the *gneiss*. In the same manner he has investigated the metamorphisms of the metalliferous rocks, especially those which are more common in nature. The ores of iron, copper, and zinc are successively examined. Trachyte, basalt, and the recent volcanic rocks ought equally to undergo metamorphisms analogous to the preceding, and Mr. Delesse thinks that these rocks are transformed into granite and into diorite.

V. Meunier.—De l'Orfévrerie Electro-Chemique; Histoire et Description. 1 vol. 12mo. 1861.—It is very generally admitted that electro-chemical gilding was invented by de Ruolz, and in France especially this name has become proverbial.

Mr. Victor Meunier attempts to demonstrate the contrary, and he brings some very strong evidence to support his views. According to his view the real inventor or the inventors were first Brugnatelli and afterwards Elkington. M. de Ruolz has merely come after them and has not even perfected the processes; such is the conclusion of the book. It is necessary to refer to the book for the documents. Our readers know that Meunier is one of the most eminent popular authors in France. His book is being extensively read and it produces a great sensation, as would be anticipated from his attempt to overthrow the honor of a name which has already become popular.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

PHYSICS.

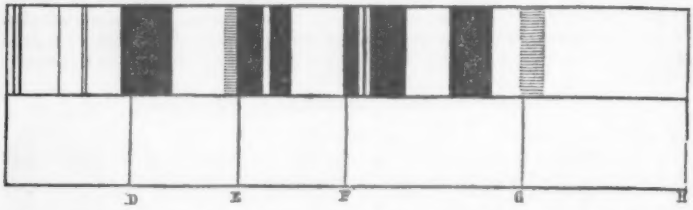
1. *On the Spectrum afforded by solution of Nitrate of Didymium.* (From a letter of Professor O. N. ROOD to Dr. WOLCOTT GIBBS.)—You will remember calling my attention to the curious fact, that Gladstone had discovered two dark lines in the spectrum furnished by light transmitted through dilute solutions of the nitrate of didymium.

I have lately repeated the experiment with the sample of this substance you kindly placed at my disposal, using quite strong solutions of considerable thickness; below is a sketch of the results obtained, which may prove of interest to you.

When the light of a lamp or sunlight is transmitted through a tube 12 inches in length, containing a strong solution of the salt in question, and afterwards analyzed by the spectroscope of Bunsen and Kirchhof, the spectrum is seen crossed by twelve distinct lines or bands, some being

very broad, while others are quite fine and require a prism of high dispersive power to effect their resolution.

Annexed is a drawing obtained by micrometrical measurements, showing their position as compared with some of the fixed lines in the solar spectrum.



D, or the sodium line is just cut off by one of these broad bands, and from this results the singular circumstance that the sodium flame becomes invisible when merely viewed through a foot of the solution, though white objects examined in the same manner appear but slightly altered in tint. This, I think, is the only case we know of where the orange ray is cut off by a nearly colorless medium.

Very sincerely, O. N. Rood.

Troy, May 21st, 1862.

2. *Effect of powdered Ice in water boiling in Glass Vessels;* by Prof. P. A. Chadbourne, of Bowdoin College.—The common experiment of pouring iron filings into water slowly boiling in smooth glass vessels to increase the ebullition can be instructively varied by substituting powdered ice or granular snow for the iron filings. Snow that has thawed partially and then frozen so as to become hard and granular is the best, but powdered ice will answer if kept so cold by freezing mixture as to be perfectly dry. If a spoonful of this ice or snow be thrown into a smooth flask nearly filled with water slowly boiling, intense ebullition at once takes place, a portion of the water being thrown out of the flask. The particles of ice thus act like particles of iron or sand, before they have time to melt and set free the steam.

3. *Galvanic Experiment.*—It is well known that the directions for repeating this experiment are, that one metal shall touch the *nerve* of the frog, the other metal the *muscle*. If instead of this arrangement the nerve be dissected out from the thigh of the frog and the current passed through the *nerve alone* the movement of the leg will be equally great. In fact, passing a current directly through one section of the nerve will produce contraction, one end of the nerve may be separated and wound like a thread around one wire, then by touching any portion of the nerve thus separated so as to pass a current through it, contractions will be produced. By touching one wire to the muscle as generally directed we have the contractions of course, because the moist muscle acts as a *conductor*; but from these experiments it would seem that the effect is produced only *by the passage of the current through a portion of the nerve.*

Chemistry.

4. *On the Oxyd of Ethylene.*—Wurtz has obtained a remarkable compound of bromine with oxyd of ethylene by mixing the two substances

in a sealed tube and allowing the mass to stand over night in a cooling mixture. Ruby-red prisms are formed which melt at 65° C. and boil at 75° C. They are insoluble in water, but soluble in alcohol and ether and have a penetrating smell. Wurtz assigns to this body the formula

$$\left.\begin{matrix}C_4H_4O_2\\C_4H_4O_2\end{matrix}\right\}Br_2 \quad \text{or} \quad \left.\begin{matrix}C_2H_4\Theta\\C_2H_4\Theta\end{matrix}\right\}Br_2$$

Treated with metallic mercury these crystals yield bromid of mercury and a colorless liquid which has a faint but agreeable smell, solidifies after fusion at +9° C. and boils at 102° C. The formula of this liquid is

$$\left.\begin{matrix}C_4H_4O_2\\C_4H_4O_2\end{matrix}\right\}$$

and the author considers it as the ether of diethylene alcohol; its derivation from this last may be represented by the equation

$$\left.\begin{matrix}C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_6-2HO=\left.\begin{matrix}C_4H_4O_2\\C_4H_4O_2\end{matrix}\right\}$$

Dyoxyethylene is soluble in all proportions in water, alcohol and ether, and combines with difficulty with anhydrous acetic acid.

When an aqueous solution of oxyd of ethylene is treated with an amalgam of sodium ordinary alcohol is formed, the equation being

$$C_4H_4O_2+H_2=C_4H_6O_2$$

Equal volumes of vapor of oxyd of ethylene and chlorhydric acid unite instantaneously and form chlorhydrate of oxyd of ethylene or glycol-monochlorhydrin.—*Comptes Rendus*, liv, 277. W. G.

5. *On new modes of forming certain hydrocarbons.*—Wurtz has studied the action of zinc-ethyl upon iodid of allyl, and has obtained in this manner hydruret of amyl, amylene, allylene and ethylene. The formation of amylene may be represented by the equation

$$C_4H_5+C_6H_5=C_{10}H_{10}$$

The other substances are produced by the reaction indicated by the equation

$$(C_4H_5)_2Zn_2+2C_6H_5I=Zn_2I_2+C_{10}H_{12}+C_6H_4+C_4H_4$$

Other hydrocarbons with a higher boiling point are also formed: one of these appears to be dyamylene, $C_{20}H_{20}$.—*Comptes Rendus*, liv, 387.

6. *On Hyperchloric Acid.*—Roscoe has carefully studied the hydrates and principal salts of hyperchloric acid. The acid may be advantageously obtained by decomposing chlorate of potash with fluosilicic acid, distilling the chloric acid and purifying the distillate by means of the hyperchlorates of silver and of barium. Pure concentrated solution of hyperchloric acid is a colorless heavy oily liquid which strongly resembles concentrated sulphuric acid. When this acid is distilled with four times its volume of concentrated sulphuric acid, a decomposition takes place at 110° C., dense white vapors pass off while a yellow insoluble liquid condenses: at 200° C. oily drops pass over and condense to a crystalline mass. The liquid is hyperchloric acid ClO_8H; the crystals are the hydrate discovered by Serullas ClO_8H+2HO. Pure hyperchloric acid, ClO_8H, is a colorless liquid of density 1·782 at 15° C.: its vapor is transparent and colorless but it forms thick white fumes in the air by attracting water. When dropped

into water the acid produces a hissing noise and the mixture is strongly heated. A drop of the acid allowed to fall on paper, wood, &c., produces explosion: on charcoal the drop explodes almost as violently as chlorid of nitrogen. The acid mixes quietly with alcohol, with evolution of heat, and formation of ether; once however a violent explosion was produced. With ether the acid uniformly explodes violently and the author suggests that possibly the hyperchloric ether of Hare and Boyé is formed. Hyperchloric acid produces upon the skin a painful wound which only heals after some months. The acid is decomposed by distillation, hyperchloric acid gas and an explosive liquid having the color of bromine being formed. Hyperchloric acid is spontaneously decomposed on keeping, even in the dark, gradually becoming darker colored and finally exploding suddenly. The hydrate of Serullas crystallizes in long needles which give off dense white vapors in the air and deliquesce rapidly. Their fusing point is 50° C. Their action on organic substances is less violent than that of the pure acid but they ignite paper and wood. The concentrated aqueous solution of hyperchloric acid contains from 71–72 per cent of ClO_3H and boils at 203° C. The author describes the hyperchlorates of ammonium, copper-ammonium, protoxyd of iron, suboxyd of mercury and lead.—*Ann. der Chemie und Pharmacie*, cxxi, 346. W. G.

7. *On hyponitric acid.*—Müller has studied the action of chlorhydric acid upon hyponitric acid obtained by the distillation of nitrate of lead. Crystallized hyponitric acid, NO_4, was found to melt at 11° 5–12° C., it absorbs chlorhydric acid readily at −22° C. and gives a yellowish-red liquid which toward the end of the operation gives off chlorine. By repeated and careful distillations two liquids were obtained, the boiling points of which were respectively −5° C. and +5° C., and nearly constant. Of these the more volatile proved to be Gay Lussac's compound NO_2Cl: the other had the formula NO_4Cl. The density of this liquid was found to be 1·32 at 14° C.; its vapor density was 2·63 by observation, 2·8 by calculation. The compound NO_4Cl is instantly decomposed by water yielding chlorhydric and nitric acids according to the equation

$$\left.\begin{matrix}NO_4\\Cl\end{matrix}\right\} + 2HO = \left.\begin{matrix}NO_4\\H\end{matrix}\right\} O_2 + HCl$$

The author suggests that the molecule $\left.\begin{matrix}NO_4\\Cl\end{matrix}\right\}$ may serve to introduce (NO_4) into organic compounds. Pentachlorid of phosphorus acts violently upon hyponitric acid, the reaction being expressed by the equation

$$NO_4 + PCl_5 = NO_2Cl + PO_2Cl_3 + Cl$$

The vapor-density of hyponitric acid was found to be 2·70 at 28° C. and 1·84 at 79° C.; the formula NO_4 requires 1·59; the formula N_2O_8 requires 3·17. Müller considers it desirable to write the formula of the liquid acid $\left.\begin{matrix}NO_4\\NO_2\end{matrix}\right\} O_2$, or $\left.\begin{matrix}N\Theta_2\\N\Theta\end{matrix}\right\} \Theta$, which in fact corresponds with Berzelieus's view that the acid is a compound of nitric and nitrous acids. Pure fluid hyponitric acid acts upon metals in such a manner that a nitrate is formed while deutoxyd of nitrogen is set free, this combines with NO_4 to form nitrous acid: the reaction is $\left.\begin{matrix}NO_4\\NO_2\end{matrix}\right\} O_2 + R = \left.\begin{matrix}NO_4\\R\end{matrix}\right\}$

O_2+NO_2. The action of hyponitric acid upon metallic oxyds yields a nitrate and nitrous acid. The action of hyponitric acid upon sulphuric acid has been studied by Weltzien. In repeating the experiments of this chemist Müller obtained the same crystalline compound and the same formula, $SO_3HO+SO_3NO_4$.—*Ann. der Chemie und Pharm.*, xlvi. 1.

W. G.

8. *On the sulphids of the alcohol radicals.*—Carius and Ferrein have obtained two oxysulphids of glycerin to which they give the names of glycerin-monosulphydrate and glycerin-disulphydrate. The compounds in question are obtained by the action of monochlorhydrin $\left.\begin{matrix}C_6H_5\\H_2\end{matrix}\right\}O_4$ Cl and $\left.\begin{matrix}C_6H_5\\H\end{matrix}\right\}O_2$ upon an alcoholic solution of sulphid of potassium. Both are oily liquids, having a faint odor of mercaptan; they are soluble in water and decomposed by distillation. The first compound has the formula $\left.\begin{matrix}C_6H_5\\H_3\end{matrix}\right\}O_4S_2$; the second is represented by $\left.\begin{matrix}C_6H_5\\H_3\end{matrix}\right\}O_2S_4$. Oxyd of mercury acts upon the disulphur compound as upon mercaptan and forms a white salt having the formula $\left.\begin{matrix}C_6H_5\\Hg_2H_3\end{matrix}\right\}O_2S_4$.—*Ann. der Chemie und Pharm.*, xlvi, 71.

W. G.

9. *On certain Ammonia-ruthenium Bases.*—Claus has discovered and described two conjugate bases containing ammonia and ruthenium, and to which he gives respectively the names of *ruthenamiak* and *ruthenbiamiak*. The author considers these bodies as containing the conjugate radicals $\widehat{NH_3}Ru$, and $2\widehat{NH_3}Ru$, which unite with an equivalent of oxygen chlorine, etc. The salts of ruthenamiak alone are described in detail; the chlorid $2\widehat{NH_3}RuCl$ is easily formed by boiling a solution of chlor-ruthenate of ammonium $RuCl_2.\widehat{NH_4}Cl$ with ammonia, evaporating the orange yellow solution to dryness, and washing the dry mass to remove sal-ammoniac. The chlorid is a beautiful yellow crystalline salt, having the formula $2\widehat{NH_3}.RuCl+3HO$. The sulphate of this base contains four, the nitrate two, and the carbonate five equivalents of water. The free base exists only in solution; it has a strong alkaline reaction and its solution can be tasted only with the utmost caution, as it produces a very painful affection of the tongue. It precipitates many metallic oxyds, and may be substituted for potash in Trommer's test for sugar. The author describes only the oxyd of ruthenamiak which has the formula $\widehat{NH_3}RuO+5$ HO, and is obtained when a solution of the last base is evaporated to dryness. This oxyd is dark yellow and crystalline; it appears to be still more caustic than the oxyd of ruthenbiamiak, and produces an even more painful disease of the tongue when tasted. In the same memoir Claus reviews the researches of Deville and Debray, and gives some modifications of his own process for resolving osmiridium and for the separation of the platinum metals.—*Journal für prakt. Chemie*, 85, p. 129, *from Bullet. de l'acad. imp. des sciences de St. Petersbourg*, T. iv.

W. G.

10. *On a method of preparing Chlorinated Organic Bodies.*—Hugo Müller finds that the replacement of hydrogen in organic bodies by

chlorine may be facilitated in an extraordinary degree by dissolving iodine in the body to be acted on, and then passing chlorine directly into the solution. In this manner benzol yields the fluid compounds $C_{12}H_5Cl$, $C_{12}H_4Cl_2$ and $C_{12}H_3Cl_3$, chlorhydric acid being evolved. Benzoic acid dissolved in chloroform is easily attacked by chlorine; bisulphid of carbon, containing iodine in solution, is decomposed by chlorine at a gentle heat, yielding chlorid of sulphur and chlorid of carbon. Large quantities of chloracetic acid may be prepared in a similar manner, even in the dark. The author believes that in most cases the iodine acts simply as a condenser of chlorine, and compares the reaction with that of the super-chlorids of phosphorus and antimony.—*Zeitschrift für Chemie und Pharmacie*, 1862, p. 99. W. G.

APPLIED CHEMISTRY.

11. *The Tannin Process;* by Prof. EDWIN EMERSON, Troy.—Photography on dry plates possesses so many advantages over the wet processes for outdoor work, that great attention has been given by scientific photographers to experiments in this department with a view either to devise some entirely new method which should not be subject to the defects attending the old methods, or so to improve some one of the known processes as to render it more easy and certain in the practical working. The vast amount of laborious research which has been made to this end, can only be appreciated by those who are familiar with the practice of Photography in its different branches.

Among the dry processes, the *Collodio-Albumen* and the *Fothergill* have, until very recently, received the most attention, and in the hands of adepts have given excellent results. But as success in these methods depends greatly upon the mechanical state of the collodion, and the favorable condition of the sensitizing bath, it is evident that neither of them can be worked with certainty by the generality of operators.

Major C. Russell, of England, after a series of experiments extending through five or six years, has perfected a dry process, now known as *the Tannin Process.* Its advantages may be briefly summed up as follows:—1. It is simple. 2. It is not dependent upon the mechanical state of the collodion. 3. A sensitizing bath in ordinary working condition is sufficient. 4. The development of the latent image is under complete control. 5. It gives, if desired, great intensity. 6. It affords an excellent *tone.* 7. The prepared plates will keep well both before and after exposure. 8. The silver, in the development is thrown down in a very finely divided state, and it is thus more favorable for obtaining extreme sharpness.

As might have been expected this process has excited great interest in the photographic world. Many experiments have been made upon it, and thus far the testimony has been uniformly in its favor. Our own observations have extended through a year and experience corroborates fully the favorable estimate which has been formed of it by others.

We give now the details of this process as worked by us:—The plate should be very carefully cleaned, and must be perfectly dry before coating with collodion; it is coated and sensitized in the same manner as for the wet process; it is then washed thoroughly in pure water, with five or six changes of water; a good plan is to have a succession of baths of pure water into which the plate can be dipped successively without removing

the plate from the dipper, as recommended by my friend F. F. Thompson, Esqr. (see *Seely's Journal* for May, 1862). After being thus washed with water it is flowed with or dipped into a bath composed of fifteen grains of Tannin dissolved in each ounce of pure water, the solution being carefully filtered. The plate should remain in this bath four or five minutes. It is then drained, and set up on one corner, on bibulous paper, to dry in a dark room or box. The ordinary exposure necessary is about four times as long as a wet plate. Two solutions are used in the development—No. 1. Pyrogallic acid 72 grains to an ounce of 95 per cent alcohol. No. 2. Nitrate of silver 20 grains, citric acid 40 grains, pure water one ounce. To develop—wet the plate rapidly with pure water, when the film is thoroughly moistened, flow the plate with water, to each drachm of which has been added two drops of No. 1, and one drop of No. 2; keep this developer in motion over the plate until the details are well out, then add to it drop by drop of No. 2, until the required intensity is obtained. Fix in hyposulphite of soda as usual.

Experience in the use of this process teaches—1. That drying by artificial heat is not necessary. 2. That the amount of acid in No. 2 may be judiciously varied with the length of exposure. It is better to have an excess of acid than too little. 3. Warming the plate in a bath of water heated 90° F., but using the developing solutions at the usual temperature, as recommended by Dr. Draper, of New York, and others, shortens the time of exposure necessary, so that this process may be worked almost as rapidly as the wet. 4. By the use of honey in combination with the Tannin, fifteen grains of each to the ounce of water as recommended by Mr. England, of London, great rapidity is gained. 5. A bromo-iodized collodion is to be preferred, and an old collodion works better in my hands than a new sample. 6. The silver bath should not be neutral, but ought to be decidedly acid; this may be done by adding one drop of nitric acid for every twelve ounces of bath. 7. This process is peculiarly adapted to the production of glass transparencies for the Stereoscope, affording great beauty and richness of tone.

II. GEOLOGY.

1. *Geology of Vermont.*—We would call attention again to the Report on the Geology of Vermont, noticed in our last volume. The work is in two volumes quarto, in all 990 pages, with numerous illustrations, besides a colored geological map of the State, and is offered for the moderate sum of five dollars. The geology of Vermont has a special interest on account of the intimate connection within the borders of the State, of metamorphic and fossiliferous rocks, and in some cases the occurrence of the latter underneath the former, or the one passing into the other. The volumes also treat very fully of the phenomena of the drift, of the river and lake terraces, elevated sea-beaches, and the fossils of the post-tertiary; also at length of the economical products of the state. With regard to copies of the work, letters should be addressed to Albert D. Hager, Proctorsville, Vermont.

2. *Mastodon tooth in Amador Co., California.*—Remains of the mastodon have been very rarely found in California. Dr. Logan of Sacramento, has sent us two photographic views of what appears to be the 6th upper

molar of *Mastodon giganteus.* This tooth was found by a miner some twenty feet below the surface, while digging for gold on Indian Creek, one of the tributaries of the Cosumnes River near Drytown, Amador county, at an elevation of about 900 feet above the sea. This discovery is interesting as showing the geographical range of the Mastodon to have been coëxtensive with the continent and not limited as some have supposed to the eastern slope of the Rocky Mountains.

3. *New species of Silurian fossils;* by E. Billings, F.G.S., Palæontologist G. S. Canada. Montreal, 6th June, 1862. pp. 67–168, 8vo.—This is a continuation of the papers formerly noticed (this Journal, [2], xxxiii, 136, 279) and contains descriptions of one hundred and six new species of fossils from the Silurian rocks of Canada with remarks upon others previously published. The new genera proposed are (1) Licrophycus for a group of fucoids; (2) Shumardia, a genus of minute trilobites allied to *Agnostus;* (3) Endymion for a genus of trilobites allied to both *Ampyxe* and *Trinucleus* and apparently standing between these two genera; (4) Trimerella, consisting of large brachiopods with three longitudinal septa in each valve supporting a flat or concave plate to which a portion of the muscular apparatus was attached, the beak solid and the area transversely striated as in the genus *Obolus.* About ninety of the species are figured.

4. *True position of the so-called Waukesha Limestone of Wisconsin.* (In a letter from Dr. C. Rominga, of Ann Arbor.)—In the local description of the Silurian strata exposed in the neighborhood of Milwaukee, a certain calcareous stratum or a complex of such is called *Waukesha limestone,* and was considered as being the base of the thick bedded fossiliferous lime rocks, considered as synchronic with the Niagara limestones.

A careful examination proves beyond all doubt, that the Waukesha limestone is in reality the superincumbent rock, and that the Niagara limestone only in disseminated spots protrudes by volcanic action in dome-like knobs through the otherwise nearly horizontal or merely undulating strata of the Waukesha limestone.

5. *Note on the Description of Lingula polita.*—We have received the following statement called out by a charge made in the paper by Mr. Billings, in the last volume of this Journal, page 420.—Eds.

Albany, May 12, 1862.

I certify that on the ninth day of February, 1861, I sent to Captain James Anderson, at that time of the Cunard Steam Ship "Canada," a box of fossils, among which were some specimens of Potsdam Sandstone from Trempaleon, Wisconsin, containing small Linguloid shells, given to me by Prof. James Hall, under the name *Lingula polita;* which name was written upon the labels sent with the specimens.

Without being able to designate the precise time, I know of my own knowledge, that at a time previous to the date specified above (9th of February 1861), Prof. Hall had made comparisons of this small fossil, with the figures and descriptions of Dr. D. D. Owen; who had designated it as *Obolus apolinus?* and that its relation to Obolus and its differences therefrom, as exhibited in figures given by Davidson, were fully discussed by Prof. Hall and myself.

[Signed] R. P. Whitfield.

6. *Descriptions of new Lower Silurian (Primordial), Jurassic, Cretaceous, and Tertiary Fossils, collected in Nebraska, by the Exploring Expedition under the command of Capt. Wm. F. Raynolds, U. S. Top. Engrs.; with some remarks on the rocks from which they were obtained;* by F. B. Meek and F. V. Hayden.—We have received a copy of the valuable memoir with the above title, from which we copy the following sections:

GENERAL SECTION OF THE CRETACEOUS ROCKS OF NEBRASKA.

	Divisions and Subdivisions.		Localities.	Estim'd thickn's.	
Upper Series.	Fox Hills beds. Formation No. 5.	Gray, ferruginous and yellowish sandstone and arenaceous clays, containing *Belemnitella bulbosa, Nautilus Dekayi, Ammonites placenta, A. lobatus, Scaphites Conradi, S. Nicolletti, Baculites grandis, Busycon Bairdi, Fusus Culbertsoni, F. Newberryi, Aporrhais Americana, Pseudo-buccinum Nebrascensis, Mactra Warrenana, Cardium subquadratum,* and a great number of other molluscous fossils, together with bones of *Mosasaurus Missouriensis,* &c.	Fox Hills, near Moreau River, — near Long Lake above Fort Pierre. Along base Big Horn Mountains, and on North and South Platte Rivers.	500 feet.	Eq. Upper or White Chalk and Maestricht beds. (*Senonien,* D'Orbigny.)
	Fort Pierre Group. Formation No. 4.	Dark gray and bluish plastic clays, containing near the upper part *Nautilus Dekayi, Ammonites placenta, Baculites ovatus. B. compressus, Scaphites nodosus, Dentalium gracile, Crassatella Evansi, Cucullæa Nebrascensis, Inoceramus Sagensis, I. Nebrascensis, I. Vanuxemi,* Bones of *Mosasaurus Missouriensis,* &c., &c., &c. Middle zone nearly barren of fossils. Lower fossiliferous zone, containing *Ammonites complexus, Baculites ovatus, B. compressus, Helicoceras Mortoni, H. tortum, H. umbilicatum, H. cochleatum, Ptychoceras Mortoni, Fusus vinculum, Anisomyon borealis, Amauropsis paludiniformis, Inoceramus sublaevis, I. tenuilineatus,* bones of *Mosasaurus Missouriensis,* &c. Dark bed of very fine unctuous clay, containing much carbonaceous matter, with veins and seams of gypsum, masses of sulphuret of iron and numerous small scales of fishes. Local; filling depressions in the bed below.	Sage Creek, Cheyenne River and on White River above the Mauvaises Terres. Fort Pierre and out to Bad Lands,—down the Missouri on the high country to Great Bend. Great Bend of the Missouri, below Fort Pierre. Near Bijou Hill, on the Missouri.	700 feet.	
	Niobrara Division. Formation No. 3.	Lead-gray calcareous marl, weathering to a yellowish or whitish chalky appearance above. Containing large scales and other remains of fishes, and numerous specimens of *Ostrea congesta* attached to fragments of *Inoceramus.* Passing down into light, yellowish and whitish limestone, containing great numbers of *Inoceramus problematicus, I. pseudo-mytiloides, I. aviculoides* and *Ostrea congesta,* fish-scales, &c.	Bluffs along the Missouri below the Great Bend, to the vicinity of Big Sioux River; also below there on the tops of the hills.	200 feet.	
Lower Series.	Fort Benton Group. Formation No. 2.	Dark gray laminated clays, sometimes alternating near the upper part with seams and layers of soft gray and light-colored limestone. *Inoceramus problematicus, I. tenuirostratus, I. latus? I. fragilis, Ostrea congesta, Venilia Mortoni, Pholadomya papyracea, Ammonites Mullani, A. percarinatus, A. vespertinus,* Scaphites Warreni, S. larvæformis, S. ventricosus, S. vermiformis, Nautilus elegans?* &c.	Extensively developed near Fort Benton on the Upper Missouri; also along the latter, from ten miles above James River to Big Sioux River, and along the eastern slope of the Rocky Mountains, as well as at the Black Hills.	800 feet.	Eq. Lower or Gray Chalk (and Upper G. Sand?) of British Geologists. (*Turonien* and *Cenomanien?* of D'Orbigny.)
	Dakota Group. Formation No. 1.	Yellowish, reddish and occasionally white, sandstone, with at places, alternations of various colored clays and beds and seams of impure lignite. Also silicified wood, and great numbers of leaves of the higher types of dicotyledonous trees; with casts of *Pharella? Dakotensis, Axinæa Siouxensis,* and *Cyprina arenaria.*	Hills back of the town of Dakota; also extensively developed in the surrounding country in Dakota County below the mouth of Big Sioux River,—thence extending southward into Northeastern Kansas and beyond.	400 feet.	

* This is *A. Texanus* of Roemer. It is on the authority of Mr. Gabb that it is here regarded as identical with *A. vespertinus* of Morton. We should never have suspected this from Dr. Morton's figure, but Mr. Gabb assures us that after a careful comparison with Dr. Morton's specimen, he can see no difference.

GENERAL SECTION OF THE TERTIARY ROCKS OF NEBRASKA.

Names.	SUBDIVISIONS.	Thickness.	LOCALITIES.	Foreign equivalents.
Loup River beds.	Fine loose sand, with some layers of limestone,—contains bones of *Canis*, *Felis*, *Castor*, *Equus*, *Mastodon*, *Testudo*, &c., some of which are scarcely distinguishable from living species. Also *Helix*, *Physa*, *Succinea*, probably of recent species. All fresh water and land types.	300 to 400 feet.	On Loup fork of Platte River; extending north to Niobrara River, and south to an unknown distance beyond the Platte.	Pliocene.
White River Group.	White and light drab clays, with some beds of sandstone, and local layers of limestone. Fossils, *Oreodon*, *Titanotherium*, *Chæropotamus*, *Rhinoceros*, *Anchitherium*, *Hyænodon*, *Machairodus*, *Trionyx*, *Testudo*, *Helix*, *Planorbis*, *Limnæa*, petrified wood, &c. &c. All extinct. No brackish water or marine remains.	1000 feet or more.	Bad Lands of White River; under the Loup River beds, on Niobrara, and across the country to the Platte.	Miocene.
Wind River Deposits.	Light gray and ash colored sandstones, with more or less argillaceous layers. Fossils, fragments of *Trionyx*, *Testudo*, with large *Helix*, *Vivipara*, petrified wood, &c. No marine or brackish water types.	1500 to 2000 feet.	Wind River valley. Also west of Wind River Mountains.	?
Fort Union or Great Lignite Group.	Beds of clay and sand, with round ferruginous concretions, and numerous beds, seams and local deposits of Lignite; great numbers of dicotyledonous leaves, stems, &c. of the genera *Platanus*, *Acer*, *Ulmus*, *Populus*, &c., with very large leaves of true *fan-palms*. Also, *Helix*, *Melania*, *Vivipara*, *Corbicula*, *Unio*, *Ostrea*, *Potamomya*, and scales of *Lepidotus*, with bones of *Trionyx*, *Emys*, *Compsemys*, *Crocodilus*, &c.	2000 feet or more.	Occupies the whole country around Fort Union, — extending north into the British possessions, to unknown distances; also southward to Fort Clark. Seen under the White river Group on North Platte River above Fort Laramie. Also on west side Wind river mountains.	Eocene ?

III. BOTANY AND ZOOLOGY.

1. *On the Various Contrivances by which British and Foreign Orchids are Fertilized by Insects, and on the Good Effects of Intercrossing.* By CHARLES DARWIN, M.A., F.R.S., &c. With illustrations. [34 figures, on wood.] London: Murray, 1862. 24mo, pp. 365.

Of all books relating to the realm of nature, perhaps the most attractive to old and young are those (such as the writings of Reaumur and Huber) which describe the habits and doings of insects. Here is a new volume of this class, bringing to view some of the numerous and most curious contrivances (a great part of them now first made known) through which insects are found to benefit the plants that nourish them. We all know how essential plants, and especially their flowers, are to the existence of the multitudinous swarms and tribes of insects; but it is hardly understood that the benefit is reciprocal—that, in the long run, insects are also essential to the continued existence of many, if not of most species of plants. "The object of the following work," the author states, "is to show that the contrivances by which Orchids are fertilized are as varied and almost as perfect as any of the most beautiful adaptations in the animal kingdom; and, secondly, to show that these contrivances

have for their main object the fertilization of each flower by the pollen of another flower." 'Adaptations'—many of them truly exquisite—and 'contrivances,' they may well be termed, being obviously as evincive of design as are analogous arrangements in the animal kingdom, from which intention is so irresistibly inferred. Indeed, had Mr. Darwin begun with this little book, and kept back a few theoretical inferences, it would have been a treasury of new illustrations for the natural theologians, and its author, perhaps, rather cannonized than anathematized, even by many of those whom his treatise on the origin of species so seriously alarmed. With how much reason, and where there may have been grounds for alarm, how far some of the positions assumed were safe and tenable, or wise, it is not our present business to consider. Our author remarks that this treatise affords him "an opportunity of attempting to show that the study of organic beings may be as interesting to an observer who is fully convinced that the structure of each is due to secondary laws, as to one who views every trifling detail of structure as the result of the direct interposition of the Creator." But the present book is almost wholly a record of observed facts, of curious interest, irrespective of all theories of origination, and perhaps as readily harmonized with old views as with new—with direct as well as with indirect creation.

The drawbacks to the general perusal and high enjoyment of this, to us so fascinating, little volume, are, first, that it demands some knowledge of botany, and the patience to master needful details, perhaps "too minute and complex for any one who has not a strong taste for natural history." But whoever will master the details, will be richly repaid for the trouble. Secondly, the Orchids illustrated are mainly British species; but several of them have close representatives in the United States, a few even are identical; and, with Darwin's treatise as a guide, the study of the fertilization of our own species will seldom be difficult, will even be all the more enticing for the chance of some novelty in the exploration of a new field. Whoever shall first study carefully the fertilization of the Orchids peculiar to this country, may hope to add something to what is now known upon this curious subject. Moreover, we are rich in the *Ophrydeæ*, or the proper Orchis tribe, with which this treatise commences, which are easy of observation, and yield to none in curious interest.

We have, indeed, only one true *Orchis* to represent the numerous European species; and this, the pretty *Orchis spectabilis*, just now in perfection throughout the northern part of the country, will be out of flower before these pages are in print. Next spring, Mr. Darwin's graphic account of the contrivance by which the pollen of one flower of *O. mascula* is made to fertilize the stigma of another flower, may be verified in all essential particulars upon our own species. The structure of the blossom being understood, or learned from the ordinary botanical works, it will be interesting to note how the pollen in each cell of the anther, tied up by delicate threads to a common stalk, although placed just above and tantalizingly close to the stigma, is incapable of reaching it; how the common stalk of each pollen mass is firmly attached to a sticky gland, belonging to the upper part of the stigma; how these two glands, or balls of viscid matter, standing side by side, are enclosed in a little pouch, which shelters the viscid balls from the air, and keeps them soft and moist; how the slightest touch of the closed pouch from above will rupture it, transversely along the top, so that the anterior part of the pouch, depressed by a slight force, will expose the sticky glands, but will rise and cover them again when the pressure is removed; how this apparatus stands projecting just over the posterior border of the entrance into the long, nectar-bearing tube or spur, which, moths, butterflies, bees, or other insects with long proboscis visit, to suck out the nectar; how a bristle, representing the proboscis, or a sharpened pencil representing the head of an insect, inserted into the spur, will, by depressing the pouch, come into contact with the glands; when their glutinous

matter, promptly hardening, like a cement, will adhere firmly to what they touch; and how, on withdrawal, one or both pollen masses, attached to the gland by their stalk or caudicle, will be drawn out of their cells and carried away; how, through a curious, probably hygrometic change of form or unequal contracility of the viscid gland, now attached to the object, the pollen-masses turn forward or become depressed, within a minute or so; and how, on returning the bristle or pencil-point to its former position, or inserting it into the nectar of another flower, the pollen will now be almost surely brought into contact with the broad viscid stigma situated just beneath the pouch and anther and the viscidity of the stigma is such, that sometimes the whole pollen mass will be left on it, but usually only a small part of it. For the elastic threads which bind the numerous packets of pollen to their common support or stalk, being weaker than the attachment of the gland to the proboscis or other object on the one hand, and than the cohesion of the pollen to the glutinous stigma on the other, some of these packets of pollen will be torn away from the mass and left on the stigma; others upon the stigma of the next flower visited, and so on.

The whole contrivance here is obvious and admirable. The hollow spur secreting nectar attracts insects, and will be habitually visited by those furnished with a proboscis adapted to reach the attractive liquid. The sticky glands are placed just where the probociss or the head of the insect must needs come in contact with them; and the protecting pouch preserves their viscidity (which here is quickly lost by drying) for the moment when it is turned to useful account. The pollen masses extracted from one flower must needs be conveyed to other flowers and other plants, and applied to their stigmas; and the cohesion of the packets of pollen, by their elastic threads, to the mass is so coördinated to the glutinosity of the stigma, as generally to ensure that the contents of the anther of one flower shall be distributed among the stigmas of several other and perhaps distant flowers, while it rarely, if ever, will reach its own. Here the closest hermaphroditism in structure subserves almost perfect diclinism in function.

We lose much in not having *Orchis pyramidalis* in this country; for its contrivances, as described by Mr. Darwin, are indeed exquisite. The figures that accompany Mr. Darwin's account render it very clear; without them a brief abstract may be hardly intelligible. The flower differs from that of other true Orchises in having two quite distinct oval stigmatic surfaces, separated by the pouch, which is here carried further downwards than usual, projecting into the nectary or spur a little below its orifice, which it partially closes. It is hollowed out on the under side in the middle, and the space is filled with fluid. The gland, or viscid disc, is single, in fact it answers to the two glands of an ordinary *Orchis* united into one, of the shape of a saddle, carrying on its flattish top or seat the stalks of the two pollen masses. "The disc is partially hidden and kept damp (which is of great importance) by the largely over-folded basal membranes of the two anther-cells. The upper membrane of the disc consists of several layers of minute cells, and is therefore rather thick. It is lined beneath with a layer of highly adhesive matter." When all is ready, if the lip of the pouch be depressed, for which the slightest touch suffices, "the under and viscid surface of the disc, still remaining in its proper place, is uncovered, and is almost certain to adhere to the touching object. Even a human hair, when pushed into the nectary, is stiff enough to depress the lip, or pouch, and the viscid surface of the saddle adheres to it. If, however, the lip be touched too slightly, it springs back, and re-covers the under side of the saddle."

"The perfect adaptation of the parts is well shown by cutting off the end of the nectary and inserting a bristle at that end, consequently in a reverse direction to that in which Nature intended moths to insert their proboscis, and it will be found that the rostellum (or pouch) may easily be torn or penetrated, but that the saddle is rarely or never caught. * * * Lastly, the labellum is

furnished with two prominent ridges, sloping down to the middle and expanding outwards, like the mouth of a decoy. These ridges perfectly serve to guide any flexible body, like a fine bristle or hair, into the minute and rounded orifice of the nectary, which, small as it is, is partially choked up by the rostellum. This contrivance of the guiding ridges may be compared to the little instrument sometimes used for guiding a thread into the fine eye of a needle.

"Now, let us see how these parts act. Let a moth insert its proboscis (and we shall presently see how frequently the flowers are visited by Lepidoptera) between the guiding ridges of the labellum, or insert a fine bristle, and it is surely conducted to the minute orifice of the nectary, and can hardly fail to depress the lip of the rostellum. This being effected, the bristle comes into contact with the now naked and sticky under-surface of the suspended saddle-formed disc. When the bristle is removed, the saddle, with the attached pollinia, is removed. Almost instantly, as soon as the saddle is exposed to the air, a rapid movement takes place, and the two flaps curl inwards and embrace the bristle. When the pollinia are pulled out by their caudicles, by a pair of pincers, so that the saddle has nothing to clasp, I observed that the tips curled inwards, so as to touch each other in nine seconds, and in nine more seconds the saddle was converted, by curling still more inwards into an apparently solid ball. * * * Of course this rapid clasping movement helps to fix the saddle with its pollinia upright on the proboscis, which is very important; but the viscid matter, rapidly setting hard, would probably suffice for this end, and the real object gained is the divergence of the pollinia. These being attached to the flat top or seat of the saddle, project at first straight up, and are nearly parallel to each other; but as the flat top curls round the cylindrical and thin proboscis, or round a bristle, the pollinia necessarily diverge. As soon as the saddle has clasped the bristle and the pollinia have diverged, a second movement commences, which, like the last, is exclusively due to the contraction of the saddle-shaped disc of membrane. . . . . This second movement is the same as that in *O. mascula* and its allies, and causes the divergent pollinia, which at first projected at right angles to the needle or bristle, to sweep through nearly 90 degrees towards the tip of the needle, so as to become depressed, and finally to lie in the same plane with the needle. In three specimens this second movement was effected in from 30 to 34 seconds after the removal of the pollinia from the anther-cells, and, therefore, in about 15 seconds after the saddle had clasped the bristle.

"The use of this double movement becomes evident if a bristle with pollinia attached to it, which have diverged and become depressed, be pushed between the guiding ridges of the labellum into the nectary of the same or another flower; . . . . for the two ends of the pollinia will be found to have acquired [as the accompanying figures show] exactly such a position that the end of the one strikes against the stigma on the one side, and the end of the other, at the same moment, strikes against the stigma on the opposite side. These stigmas are so viscid, that they rupture the elastic threads by which the packets of pollen are bound together; and some dark green grains will be seen, even by the naked eye, remaining on the two white stigmatic surfaces. I have shown this little experiment to several persons, and all have expressed the liveliest admiration at the perfection of the contrivance by which this Orchid is fertilized.

"As in no other plant, or indeed in hardly any animal, can adaptations of one part to another, and of the whole to other organized beings widely remote in the scale of Nature, be named more perfect than those presented by this Orchis, it may be worth while briefly to sum them up. As the flowers are visited both by day and night-flying Lepidoptera, I do not think it is fanciful to believe that the bright purple tint (whether or not specially developed for this purpose) attracts the day-fliers, and the strong foxy odor the night-fliers. The upper sepal and the two upper petals form a hood, protecting the anther and the stigmatic surfaces from the weather. The labellum is developed into a

long nectary, in order to attract Lepidotera; and we shall presently give reason for suspecting that the nectar is purposely so lodged that it can be sucked only slowly, in order to give time for the curious chemical quality of the viscid matter setting hard and dry. He who will insert a fine and flexible bristle into the expanded mouth of the sloping ridges on the labellum, will not doubt that they serve as guides, and that they effectually prevent the bristle or the proboscis from being inserted obliquely into the nectary. This circumstance is of manifest importance; for, if the proboscis were inserted obliquely, the saddle-shaped disc would become attached obliquely, and after the compounded movement of the pollinia they could not strike the two lateral stigmatic surfaces.

"Then we have the rostellum partially closing the mouth of the nectary, like a trap placed in a run for game; and the trap so complex and perfect, with the symmetrical lines of rupture forming the saddle-shaped disc above, and the lip of the pouch below; and lastly, this lip so easily depressed that the proboscis of a moth could hardly fail to uncover the viscid disk and adhere to it. But if this did fail to occur, the elastic lip would rise again and re-cover and keep damp the viscid surface. We see the viscid matter within the rostellum attached to the saddle-shaped disc alone, and surrounded by fluid, so that the viscid matter does not set hard till the disc is withdrawn. Then we have the upper surface of the saddle, with its attached caudicles, also kept damp within the basis of the anther-cells, until withdrawn, when the curious clasping movement instantly commences, causing the pollinia to diverge, followed by the movement of depression, which compounded movements together are exactly fitted to cause the ends of the two pollinia to strike the two stigmatic surfaces. These stigmatic surfaces are just sticky enough not to tear off the whole pollinium from the proboscis of the moth, but by rupturing the elastic threads to secure a few packets of pollen, leaving plenty for other flowers. But let it be observed that, although the moth probably takes a considerable time to suck the nectar of any one flower, yet the movement of depression in the pollinia does not commence (as I know by trial) until the pollinia are fairly withdrawn out of their cells; nor will the movement be completed, and the pollinia be fitted to strike the stigmatic surfaces, until about half a minute has elapsed, which will give ample time for the moth to fly to another plant, and thus effect a union between two distinct individuals."

Mr. Darwin subjoins a list of twenty-three species of Lepidoptera, to the proboscis of which the pollinia of *O. pyramidalis* have been found attached, four of them in more than one instance; a large majority carrying two or three pairs, one seven pairs, and another no less than eleven pairs, all invariably attached to the proboscis. A figure is given of the head and proboscis of an *Acontia*, bearing seven pairs of pollinia, attached one before the other, with perfect symmetry, as follows from the insertion of the proboscis having been guided by the ridges on the labellum; and he remarks that an unfortunate *Caradrina*, with its proboscis encumbered by eleven pairs, could hardly have reached the extremity of the nectary, and would soon have been starved to death. "These two moths must have sucked many more than the seven and eleven flowers, of which they bore the trophies; for the earlier attached pollinia had lost much of their pollen, showing that they had touched many viscid stigmas. * * * "In *O. pyramidalis* I have examined spikes, in which every single expanded flower had its pollinia removed. The 49 lower flowers of a spike from Folkstone (sent me by Sir Charles Lyell) actually produced 48 fine seed capsules; and of the 69 lower flowers in three other spikes, seven alone had failed to produce capsules." And pollen is often found on stigmas of flowers of Orchids which had not their own pollinia removed, while in others the pollinia had been carried away, but no pollen as yet left on their stigmas. "These facts show conclusively how well moths had performed their office of marriage priests."

Now, is it credible that all this admirable apparatus and these well-ensured

and beneficial results are undesigned? On the supposition that *Orchis pyramidalis* was independently originated as it is, it would not be credible, nor would any one, probably, ever think of raising the question. Although supposable, would the absence of design be much less incredible, on the assumption that the Orchis we have been considering was the progeny (remote or near) of some ancestor which, like several existing Orchises, had the two viscid discs in close apposition, and *that* the progeny of another, which, like most species, had them distinctly separate? it being premised that both the ancestral forms were as perfect in their structure, and as well adapted to their surroundings, as the species with which we have compared them actually are. But we have no desire nor particular occasion to reopen this question now.

To return to our Orchids. The plan or general structure of the flower is the same in all the *Ophrydeæ;* but the particular contrivance varies from species to species, and from one genus to another. One British plant of the tribe, the *Bee Ophrys*,—so various are the resources of nature—differing in this respect even from its congeners, is adapted for self-fertillization, without insect aid. And the way in which the same Orchid-structure ordinarily adapted to insect coöperation, is made to do its own work, and do it well, assisted only by a breath of wind, is abundantly curious.

In the genus *Habenaria*, or *Platanthera*, the anther-cells are more separated and divergent, so that the glands or viscid discs are carried one to each side of the broad stigma, and there is no pouch; but the sticky disc, in some of our species, looking like a little pearl button, is perfectly naked; and when the flower-bud opens, stands directly in the way of the head of a moth or bee, thrusting its proboscis into the nectar-bearing spur. And here the viscidity of the disc, or gland, is beautifully adapted to that state of things. For, although fully exposed to the air, instead of setting hard at once, as in *Orchis*, the disc retains its viscidity during the whole period of anthesis, awaiting the coming of the insect, and quite sure to stick fast to the side of the face of the first one that dips its proboscis into the attractive nectary. The closest analogues we have of the British *Habenaria chlorantha*, so interestingly described by Mr. Darwin, are our *Platanthera orbiculata*, which is not yet in blossom, and *P. Hookeri*, upon which (as our delighted pupils may testify,) Mr. Darwin's details of the contrivance for the fertilization and pretty sure intercrossing of the individuals of the British species may be verified. It is a pretty experiment to bring the head of a butterfly or bee into the proper position, and to see how deftly the disc on each side attaches itself to the eye of the insect, making the animal carry off the pollinia upon withdrawal and migration to another blossom, —to see the pollinia turn inwards and downwards by a double movement, each of about 40 degrees, so that when now applied to the same or another flower, the pollinia no longer will strike against the anther-cells from which they were extracted, but against the broad stigmatic surface below and between. These movements of depression and rotation are best observed, and the intention demonstrated, by applying the tip of the finger or a small slip of glass to the gorge of the flower, so extracting the pollinia, and noticing that the latter, if immediately returned, would be applied to the cells from which they were taken, but that, after the lapse of a minute or less, they have so changed their direction, that now a return of the finger to the same place will pretty surely bring the pollen into contact with the stigma.

In two particulars our *P. Hookeri* differs most obviously from *Habenaria chloranthi*: its anther cells are still more widely divergent, and the labellum is incurved instead of being dependent. And these two particulars seem as if designedly correlated. The nectary of the British species, with hanging labellum, is most accessible by a direct front approach; and an insect whose face would touch and extract both of its pollinia, might, in that position, fail to hit either of the more widely separated discs of *P. Hookeri*. But while a moth of sufficient size would press down the labellum of the latter, using it as a landing place, and probably extract both pollinia at once, smaller insects would have to approach on one or the other side of it, and so be sure to hit one pollinium.

Our *Platanthera bracteata*, which is early flowering, serves completely to exemplify Mr. Darwin's account of the mechanism of *Peristylus viridis* (except as to the early pouch for the viscid discs, which the specimens brought us are too advanced to show, but which are likely to confirm the genus *Peristylus)*; and the whole leaves scarce a doubt of the specific identity of the American and European plants, which botanists have strongly suspected.

Our Fringe Orchises and other Platantheras, blossoming later in the summer, will doubtless furnish interesting and varied illustrations of fertilization by insect aid; and we commend them, with Darwin's charming book as a guide, to all curious and interested observers. We have gone over two chapters only of this book, treating of one tribe of Orchids, and here we must drop it for the present, remarking that the five remaining chapters, so far as we have looked into them,—relating in part to tropical forms,—seem to be no less captivating than those which have give such new and surpassing interest to our most familiar Orchideous plants. A. G.

2. *Outlines of the Distribution of Arctic Plants*, with a map. By Jos. D. Hooker, M.D., F.R.S. (Extr. Linn. Trans., vol. xxiii, pp. 251–348. Read, June, 1860; issued, Oct. 1861.)

We have mentioned this important memoir already in the May number of this Journal, p. 404; have commented upon certain details as they came in the writer's way; and, in the concluding portion of the Report upon Dr. Parry's Rocky Mountain Collection, (which, from the press of other matter, is unavoidably deferred to the ensuing number,) other particulars and special botanical criticisms of this sort will find an appropriate place. Here, instead of such *minutiæ*, which only the systematic botanist could understand or care for, we wish to consider the general plan and character of a treatise upon which a vast amount of labor and knowledge has been lavished.

The immediate subjects of the treatise are the Arctic plants, of every phænogamous species known to occur spontaneously anywhere within the Arctic circle; the geographical distribution of which, so far as known, is carefully indicated: 1. Within the Arctic region, under the several divisions—Europe, Asia, W. America (Behring's Straits to the Mackenzie River), E. America (Mackenzie River to Baffin's Bay), and Arctic Greenland. 2. Without this circle, and under the general divisions of N. and Central European and N. Asiatic Distribution, with three longitudinal subdivisions; American Distribution, with appropriate subdivisions; S. European and African Distribution; Central and S. Asiatic Distribution. The theory upon which the facts are collocated and discussed, and which they are thought strongly to confirm, is that of Edward Forbes, which was completed, if not indeed originated by Darwin:—"first, that the existing Scandinavian flora is of great antiquity, and that previous to the glacial epoch it was more uniformly distributed over the Polar Zone than it is now; secondly, that during the advent of the glacial period this Scandinavian vegetation was driven southward in every longitude, and even across the tropics into the south temperate zone; and that, on the succeeding warmth of the present epoch, those species that survived both ascended the mountains of the warmer zones, and also returned northward, accompanied by aborigines of the countries they had invaded during their southern migration. Mr. Darwin shows how aptly such an explanation meets the difficulty of accounting for the restriction of so many American and Asiatic arctic types to their own peculiar longitudinal zones, and for what is a far greater difficulty, the representation of the same arctic genera by closely allied species in different longitudes. * * * Mr. Darwin's hypothesis accounts for many varieties of one plant being found in various alpine and arctic regions of the globe, by the competition into which their common ancestor was brought with the aborigines of the countries it invaded. Different races survived the struggle for life in different longitudes; and these races again, afterwards converging on

the zone from which their ancestor started, present there a plexus of closely allied but more or less distinct varieties, or even species, whose geographical limits overlap, and whose members, very probably, occasionally breed together." A further advantage claimed for this hypothesis is, that it explains a fact brought out by Dr. Hooker in a former publication, viz.: "that the Scandinavian flora is present in every latitude of the globe, and is the only one that is so."

Moreover, Dr. Hooker discovers in the flora of Greenland a state of things explicable upon this hypothesis, but hardly by any other, viz.: its almost complete identity with that of Lapland; its general paucity, as well as its poverty in peculiar species; the rarity of American species there; the fewness of temperate plants in temperate Greenland; and the presence of a few of the rarest Greenland and Scandinavian species in enormously remote alpine localities of West America and the United States. Our author reasons thus: "If it be granted that the polar area was once occupied by the Scandinavian flora, and that the cold of the glacial epoch did drive this vegetation southwards, it is evident that the Greenland individuals, from being confined to a peninsula, would have been exposed to very different conditions from those of the great continents. In Greenland many species would, as it were, be driven into the sea, that is, exterminated; and the survivors would be confined to the southern portion of the peninsula, and, not being there brought into competition with other types, there could be no struggle for life amongst their progeny, and, consequently, no selection of better adapted varieties. On the return of heat survivors would simply travel northwards, unaccompanied by the plants of any other country."

The rustic denizens of Greenland, huddled upon the point of the peninsula during the long glacial cold, have never enjoyed the advantages of foreign travel; those of the adjacent continents on either side have 'seen the world,' and gained much improvement and diversity thereby. Considering the present frigid climate of Greenland, the isotherm of 32° just impinging upon its southern point, its moderate summer and low autumnal temperature, we should rather have supposed the complete extermination of the Greenland ante-glacial flora; and have referred the Scandinavian character of the existing flora (all but eleven of the 207 arctic species, and almost all those of temperate Greenland, being European plants,) directly to subsequent immigration from the eastern continent. Several geographical considerations, and the course of the currents, which Dr. Hooker brings to view on p. 270, would go far towards explaining why Greenland should have been re-peopled from the Old rather than from the New World. While the list (on p. 272, 273) of upwards of 230 Arctic-European species which are all likewise American plants, but are remarkable for their absence from Greenland, would indicate no small difficulty in the westward migration, and render it most probable that the diffusion of species from the Old world to the New was eastward through Asia, for the *arctic* no less than (as has elsewhere been shown) for the *temperate* plants. Was it that Greenland and the adjacent part of the American continent remained glacial longer than the rest of the zone? And if our northern regions were thus colonized by an ancient Scandinavian flora, this seems to have been in return for a still earlier donation of American plants to Europe, to which a very few existing but numerous fossil remains bear testimony. Speculative enquiries of this sort are enticing, and the time is approaching in which they may be fruitful.

Indeed, the characteristic features and the immediate interest and importance of the present memoir, as of others of the same general scope and interest, are found in this: 1. That the actual geographical distribution of species is something to be accounted for; 2. That our existing species, or their originals, are far more ancient than was formerly thought, mainly if not wholly antedating the glacial period; and, 3. That they have therefore been subject to grave climatic vicissitudes and changes. There may be many naturalists

who still hesitate to accept these propositions, as there are one or two who deny them; but these or similar conclusions have evidently been reached by those botanists, paleontologists, and geologists in general who have most turned their thoughts to such enquiries, and who march foremost in the advancing movement of these sciences. In this position, the author of the present memoir—prepossessed with Darwin's theory of the diversification of species through natural selection—having occasion to revise systematically the materials of the arctic flora, is naturally led to compare the new theory with the facts of the case in this regard; to see how far the vicissitudes to which it is all but demonstrated that the plants of the northern hemisphere have long been subjected, and the modifications and extinctions which he thinks must have ensued under such grave changes and perils, during such lapse of time, may serve to explain the actual distribution of arctic species and the remarkable dispersion of many of them. That the enquiry is a legitimate and a hopeful one we must all agree, whether we favor Darwinian hypotheses or not. How well it works in the present trial we could not venture to pronounce without a far more critical examination than could now be undertaken. But there are good reasons for the opinion that this is just the ground upon which the elements of the new hypothesis figure to the best advantage.

The mass of facts, so patiently and skillfully collected and digested in this essay, have a high and positive value, irrespective of all theoretical views. We cannot undertake to offer an abstract, but may note here and there a point of interest. The flowering plants which have been collected within the arctic circle number 762, viz.: 214 Monocotyledons, and 548 Dicotyledons. They occupy a circumpolar belt of 10° to 14° of latitude. The only abrupt change in the vegetation anywhere along this belt is at Baffin's Bay, the opposite shores of which present, as has been already intimated, an almost purely European flora on the east coast, but a large admixture of purely American species on the west.

"Regarded as a whole, the artic flora is decidedly Scandinavian; for Arctic Scandinavia, or Lapland, though a very small tract of land, contains by far the richest arctic flora, amounting to three-fourths of the whole." This would not be very surprising, since this is much the least frigid portion of the zone, and has the highest summer temperature; but "upwards of three-fifths of the species, and almost all the genera of Arctic Asia and America are likewise Lapponian;" so that the Scandinavian character pervades the whole.

In the section on the local distribution of plants within the arctic circle, Dr. Hooker shows that there is no close relation discoverable between the isothermal lines (whether annual or monthly) and the amount of vegetation, beyond the general fact that the scantiness of the Siberian flora is associated with a great southern bend in Asia, and its richness in Lapland, with an equally great northern bend there, of the annual isotherm of 32°. Yet "the same isotherm bends northwards in passing from Eastern America to Greenland, the vegetation of which is the scantier of the two; and it passes to the northward of Iceland, which is much poorer in species than those parts of Lapland to the southward of which it passes." A glance at the supposed former state of things would suggest the explanation of all that is anomalous here.

"The June isothermals, as indicating the most effective temperatures in the arctic regions (when all vegetation is torpid for nine months, and excessively stimulated during the three others) might have been expected to indicate better the positions of the most luxuriant vegetation. But neither is this the case; for the June isothemal of 41°, which lies within the arctic zone in Asia, where the vegetation is scanty in the extreme, descends to lat. 54° in the meridian of Behring's Straits, where the flora is comparatively luxuriant." The aridity of the former, and the humidity of the latter district here offers an obvious explanation; also the great severity of the winter in the former, and its mildness in the latter. And Great Britain, in which a far greater diversity of species are capable of surviving without protection than in the Eastern United

States under the same annual isotherms, indicates the advantage of a mean over an extreme climate in this respect, if only there be a certain amount of summer heat. For lack of that, doubtless, very many of the introduced denizens of Britain would soon disappear, if deprived of human care.

"The northern limit to which vegetation extends varies in every longitude; the extreme is still unknown; it may, indeed, reach to the pole itself. Phœnogamic plants, however, are probably nowhere found far north of lat. 81°. Seventy flowering plants are found in Spitzbergen; and Sabine and Ross collected 9 on Walden Island, towards its northern extreme, but none on Ross's Islet, 15 miles further to the north."

"*Saxifraga oppositifolia* is probably the most ubiquitous, and may be considered the commonest and most arctic flowering plant." There are only eight or nine phænogamous species peculiar to the arctic zone, and only one peculiar genus, viz.: the grass, *Pleuropogon*.* Of the 762 found south of the circle, all but 150 have advanced beyond lat. 40° N., in some part of the world; about 50 of them are identified as natives of the mountainous regions of the tropics, and 105 as inhabiting the south temperate zone.

"The proportion of species which have migrated southward in the Old and New World also bear a fair relation to the facilities for migration presented by the different continents." The tables given to illustrate this "present in a very striking point of view the fact of the Scandinavian flora being the most widely distributed over the world. The Mediterranean, South African, Malayan, Australian, and all the floras of the New World, have narrow ranges compared with the Scandinavian, and none of them form a prominent feature in any other continent than their own. But the Scandinavian not only girdles the globe in the arctic circle, and dominates over all others in the north temperate zone of the Old World, but intrudes conspicuously into every other temperate flora, whether in the northern or southern hemisphere, or on the Alps of tropical countries." * * * "In one respect this migration is most direct in the American meridian, where more arctic species reach the highest southern latitudes. This I have accounted for (Flora Antarctica, p. 230) by the continuous chain of the Andes having favored their southern dispersion."

In presenting the actual number of arctic species, and in delineating their geographical ranges, the question, what are to be regarded as species, becomes all important. As to this, it does not so much matter what scale is adopted, as to know clearly what the adopted scale is. Here we are not left in doubt. Taking European botanists by number, we are confident that nine out of ten would have enlarged the list of 762 phænogamous arctic species to 800 or more, and would not have recognized a goodly number of the synonyms adduced, thereby considerably affecting the assigned ranges, especially into temperate and austral latitudes. In this regard we should side with Dr. Hooker on the whole, but with differences and with questionings—with halting steps following his bold and free movement, but probably arriving at the same goal at length. Indeed, we freely receive the view which Dr. Hooker presents as appropriate to his particular purpose, and as the most useful expression of our knowledge of the relationships of the plants in question, when collocated in reference to the ideas upon which this memoir is based. That is: "if, with many botanists, we consider these closely allied varieties and species as derived by variation and natural selection from one parent form at a comparatively modern epoch, we may with advantage, for certain purposes,

* *Douglasia* is mentioned in another place (p. 269) as an absolutely peculiar arctic or arctic-alpine genus of E. America. But we have considered this genus as identical with *Gregoria*, of Duby. It would appear as if these two genera were established in the same year, since Lindley himself, in the Botanical Register, refers to Brande's Journal for January, 1828, for his original article. But this article will be found in the volume of that Journal for 1827; so that the name *Douglasia* is to be adopted, if the genus is sufficiently distinct from *Androsace*.

regard the aggregate distribution of such very closely allied species as that of one plant." "An empirical grouping of allied plants, for the purposes of distribution, may thus lead to a practical solution of difficulties in the classification and synonymy of species. My thus grouping names must not be regarded as a committal of myself to the opinion that the plants thus grouped are not to be held as distinct species. * * * My main object is to show the affinities of the polar plants, and I can best do this by keeping the specific idea comprehensive." And further: "I wish it then to be clearly understood, that the catalogue here appended is intended to include every species hitherto found within the arctic circle, together with those most closely allied forms which I believe to have branched off from one common parent within a comparatively recent geological epoch, and that immediately previous to the glacial period or since then" (p. 279). All we could ask more would be some distinction (typographical or other), to mark 1, undoubted and complete synonyms; 2, mere variations or states, local or otherwise, or undoubted varieties; 3, such as, theory apart, would claim to be regarded as distinct but closely related species. For example: to take one order, while *Rhinanthus minor* may well be considered as "not a sufficiently constant form to rank as a race even," while *Limosella tenuifolia* could rank for no more than a race, and while *Castilleia septentrionalis* and *C. pallida*, we are now convinced, however distinct in this single character, differ only (and inconstantly) in the relative development of the galea, we think it likely that *Pedicularis lanata*, Willd., does not rightfully merge in *P. hirsuta* this side of the glacial period, although it perhaps may into *P. Langsdorffii*, and that into *P. Sudetica*. But this is no place for criticisms upon the limitation of species, upon which the opinions of botanists will so greatly depend upon the amount of their materials, and upon which the best considered opinions must be subject to frequent revisal. Nor does the value of the present memoir at all depend upon the settlement of such points. To the philosophical naturalist, as to the archeologist, just now the most interesting and pregnant epoch of the world's natural history is that immediately antecedent to the present, that near past from which the present has proceeded, and upon which so much light, from very diverse sources, is now being concentrated: towards its elucidation the memoir we have been considering is a very valuable contribution. A. G.

3. *On the Cedars of Lebanon, Taurus, Algeria and India.* By J. D. Hooker, M.D., F.R.S.

This paper, reprinted from the Natural History Review for January, 1862, (with 3 plates,) is one of the results of a visit to Mount Lebanon, in the autumn of 1860, upon the invitation of Capt. Washington, Hydrographer to the British Navy, for the purpose, among other things, of examining the famous Cedar Grove,—of which we have all heard so much and know so little. An interesting account is given of the grove and of the position it occupies, upon the floor of a basin, "crossed abruptly and transversely by a confused range of ancient moraines .... perhaps 80 to 100 feet high .... which have been deposited by glaciers that, under very different conditions of climate, once filled the basin above them, and communicated with the perpetual snow with which the whole summit of Lebanon was, at that time, deeply covered."

"The number of trees is about 400, and they are disposed in nine groups, corresponding with as many hummocks of the range of moraines; they are of various sizes, from about 18 inches to upwards of 40 feet in girth; but the most remarkable and significant fact connected with their size, and consequently with the age of the grove, is that there is no tree of less than 18 inches girth, and that we found no young trees, bushes, nor even seedlings of a second years growth. We had no means of estimating accurately the ages of the youngest or oldest tree: nor shall we have, till the specimens of the former arrive. It may be remarked, however, that the wood of the branch of the old

tree, cut at the time, is eight inches in diameter (exclusive of bark), presents an extremely firm, compact, and close-grained texture, and has no less than 140 rings, which are so close in some parts that they cannot be counted without a lens. This specimen further, is both harder and browner than any English-grown Cedar or native Deodar, and is as odoriferous as the latter. These, however, are the characters of an old lower branch of a very old tree, and are no guide to the general character of the wood on the Lebanon, and still less to that of English-grown specimens, which are always very inferior in color, odor, grain, and texture. Calculating only from the rings in this branch, the youngest trees in Lebanon would average 100 years old, the oldest 2500, both estimates no doubt widely far from the mark. Calculating from trunks of English rapidly-grown specimens, their ages might be calculated as low respectively as 5 and 200 years; while from the rate of growth of the Chelsea Cedars, the youngest trees may be 22, and the oldest 6 to 800 years old.

"The positions of the oldest trees (of the 400) afforded some interesting data relative to the ages of the different parts of the grove, and the direction in which it had lately spread. There were only 15 trees above 15 feet in girth, and these all occurred in two of the nine clumps, which two contained 180 trees. Only two others exceeded 12 feet in girth, and these were found in immediately adjoining clumps, one on one side and one on the other of the above mentioned. There were five clumps containing 156 trees, none of which was above 12 feet in girth, and these were all to the westward, (or down-valley) side of the others. On this side, therefore, the latest addition to the grove has taken place.

"Whether the grove has much diminished within the historic period, is a question which can only be decided by a careful collection and scrutiny of the records of old travellers. It would not surprise me, if proofs existed of its not having materially decreased since the days of Solomon; for it is very doubtful whether the wood was ever largely used in Jerusalem for building purposes."

"On the other hand, that the grove has, within the historic period, increased and diminished in extent, owing to secular changes in the climate, cannot be doubted, when it is remembered, that no seedling has come to maturity (though thousands annually germinate), since the birth of trees the youngest of which is 18 inches in girth; and that the whole grove presents such a disparity in the ages of its trees, that only about 15 exceed as many feet in girth, and 385 fall below 12 feet girth. Upon this point I have collected some curious corroborative evidence, from the works of old travellers."

The Cedar also grows on the chain of the Taurus, 250 miles off. Fourteen hundred miles off in another direction, separated by the whole breadth of the Mediterranean sea, are the forests of *Cedrus Atlantica* of Algeria. "The African Cedar differs from that of Lebanon in having a perfectly erect, rigid leader, and stiff ends to the branches, all which, in the Lebanon plant, drop more or or less," and there are other but more variable differences. Fourteen hundred miles in the other direction reach to the borders of the Cedar forests of Affghanistan, which extend eastward almost to Nepal. The Himalayan Cedar, or Deodar, *C. Deodara*, "has a much more pendulous leader and end to its branches, and longer leaves, of a more glaucous hue than *C. Libani*, though not such silvery leaves as the *C. Atlantica*. The cones are as large as those of *C. Libani*, but the scales and seeds are of the same form as those of *C. Atlantica*, and hence markedly different from those of *C. libani*.

"From what has been said respecting each of these Cedars, it is evident, that the distinctions between them are so trifling, and so far within the proved limits of variation of Coniferous plants, that it may reasonably be assumed that all originally sprang from one. It should be added, that there are no other distinctions whatever between them—of bark, wood, leaves, male-cones, anthers, or the structure of these—nor in their mode of germination or duration, the girth they attain, or their hardiness. Also, that all are very variable in habit;

so much so, indeed, is this the case with the Deodar, which is the most distinct of all in habit, that though it was not introduced much more than thirty years ago, there are already five distinct varieties sold by nurserymen, some as stiff, others as dark-colored, and others as short-leaved as the Lebanon Cedar. Also, that though the difference in the shape of the scales and seeds of *Deodara* and *Libani* are very marked, they vary much; many forms of each overlap; and further transitions between the most disimilar, may be established by intercalation of seeds and scales from *C. Atlantica*."

"Hitherto, *C. Atlantica* has been almost universally considered a variety of *Libani* and *C. Deodara* a different species; habit having been relied upon exclusively, and botanical characters neglected; for a glance at the drawings shows that there is an obvious and marked difference, in the latter respect, between the common states of *Atlantica* and *Libani*, and none between *Atlantica* and *Deodara*. This is perplexing, for, as I have said above, *C. Libani* holds an intermediate position, both geographically and in characters of foliage, between the two that agree in the most important characters; and further, we can account, in a great measure, for the differences of habit, by the climate of the three localities; the most sparse, weeping, long-leaved Cedar is from the most humid region, the Himalaya; whilst the plant of most rigid and otherwise opposite habit, corresponds with the climate of the country under the influence of the great Sahara desert. No course remains, then, but to regard all as species, or all as varieties, or the *Deodara* and *Atlantica* as varieties of one species, and *Libani* as another. The hitherto adopted and only alternative, of regarding *Libani* and *Atlantica* as varieties, and *Deodara* as a species, must be given up."

Dr. Hooker accordingly regards the three Cedars as three well-marked forms, usually very distinct, and so far permanent that, although of common origin, they will not revert again one to the other, or all to a common ancestral type. Upon his view, therefore, here are three forms, which, under variation, geographical segregation, and the suppression of intermediate states, have become fixed into what are generally called nearly related, representative species.

Finally he asks, how does it happen that they are now so sundered geographically? The answer to this question he derives from a consideration of the glacial period, when the Cedars of Lebanon must have been fully 4,000 feet lower than they are now, and continuous with those of Taurus, which also descended to the same lower level, and along the Persian mountains were connected with their Himalayan brethren, which also, upon the evidence of glaciers, must then have descended to fully 4,000 feet below their present level. The Algerian forests present more difficulty. For their solution the recent discoveries of extensive comparatively modern changes in the form and extent of the Mediterranean are confidently appealed to; the remains of the African Hippopotamus and Rhinoceros in Sicily so obviously indicating a continental extension from the Tunis coast to that Island, and the soundings lending corroboration to this view. If a forest thus extended at the glacial period will account for the diffusion of the Cedars, the succeeding warm period driving them northward and up the mountains, with the consequent extinctions, may well account for the present separation and for the present differences of the three surviving races. A. G.

4. *Weddell's Chloris Andina* has advanced to the close of the second volume with the 16th *livraison*, issued Nov. 1861, thus finishing the Monopetalous and most of the Polypetalous orders. As to *Plantago*, while adopting and confirming Decaisne's hint that the species are vastly overdone in the Prodromus, Weddell has not sufficiently, if at all, recognized the diœcio-dimorphism which pervades the genus, and which in this country has long been understood. This, however, is most conspicuous in some groups of species which, not rising into the high Andes, are beyond the limits of his work.

Gaultheria, as Kalm, the founder of the genus, wrote the name, being dedicated to Dr. Gaulthier, it is a good idea of Weddell's to insert the missing vowel, thus by a slight change making the name of the genus, *Gaulthieria*, conform with that of the person commemorated. That it should have been so written in the first instance is clear enough; but it is doubtful if it be now worth while to change the original orthography, which is not far amiss. *Gaylusacia* is by no means peculiar to South America; Dr. Weddell must have casually overlooked the North American species.

The remark that the seeds afford characters by which the species of *Epilobium* may be distinguished, is worthy of attention. They do afford good characters in *Œnothera*.

We cannot agree with Dr. Weddell in restricting the genus *Malvastrum* to that marked group the *Phyllanthophora*. Thus restricted it would none the less rest upon a single character, and that one pertaining to the organs of vegetation; while a general view of the tribe will, we think, lead to the conclusion that the distinction between the styles with capitate stigma and those which are introrsely stigmatose is here well marked and well correlated with real affinities—that, in fact, *Malvastrum*, as a whole, and especially those species which are referred back by Weddell to *Malva*, are really more closely related to *Sida* and to *Sphæralcea* than to the genuine, old-world *Malva*.

The fact is overlooked that *Myosurus apetalus*, Gay, is often petaliferous, and occurs in North America.

Our remarks naturally run to criticisms of certain details. There can be no question that the Flora Andina is a work of a high order of merit. A. G.

Zoology.—

5. *Histoire Naturelle des Zoophytes Echinodermes.* . . . . par M. F. Dujardin et par M. H. Hussé, Paris. Encyclopédie Roret. 1862.—It would naturally be supposed that a work on Echinoderms appearing in 1862 would advance in some degree our knowledge of that class; the more so as the authors had access to the Collections of the Jardin des Plantes and to the best libraries of Paris. The authors had at their disposal the original specimens of Lamarck and could have cleared up many doubtful points, and it was at least to be expected that this volume should be a faithful record of what had been done in the different orders of Echinoderms up to the time of publication. Instead of this it is a crude compilation of some of the most important works, made without any discrimination. The authors adopt or reject this or that classification at their pleasure without attempting to combine what there may be of truth in the different writers. The literature of later years seems to have escaped their notice entirely. Their ignorance of what has been done by American writers can hardly be excused on the ground of the difficulty of obtaining American publications in Europe. Wiegmann's Archiv which they quote so frequently contains in the excellent Reports of Prof. Luckart all that they needed to become acquainted with the papers of our American Naturalists on Crinoids, Starfishes, Echini and Holothurians. Their neglect is not confined to this side of the Atlantic, even the papers of Gray, of Peters, of Philippi are left unnoticed. It would be an endless task to enumerate the errors which have made this book a useless one, a needless addition to our overburdened scientific literature.

What confidence can we have in a compilation in which we are told that *Cidaris imperialis* Lam. is found in New Holland; that *Astropyga radiata* Gray, comes from South America and *Nucleolites recens* from the Antilles, although a few lines above we had been informed that the single living representative of the genus Nucleolites was found in New Holland,

and finally on page 541 *Echinometra Quoyi*, U. is said to be the young of *Podophora atrata* and on page 539 the same *Echinometra Quoyi*, U. is quoted as a species of the genus Echinometra!! What reliance can be placed in the characteristics of genera such as Leiocidaris in which we have given as generic, "Radioles en forme de longues baguettes sont toujours cylindriques et lisses," and on the next page we find as the specific character of *Leiocidaris* (Cidaris) *Thouarsii* "radioles subcylindriques très granuleux," *Cidaris hystrix* and *Cidaris papillata* are also referred to Leiocidaris though their spines are anything but "lisses" and "cylindriques." There is no uniformity in their nomenclature; we find for instance *Leiocidaris imperialis* Lam. immediatey below *Leiocidaris hystrix* Desor, for what reason we are not told. On one page the species is credited to the author who first described it, no matter to what genus it has been afterwards removed, while on the next page the opposite course will be followed and the species credited to the author who first placed it in its proper genus. The authors are equally unfortunate in their synonymic lists, these lists have been simply copied; they have not taken the trouble to compare their quotations: as for example in *Cidaris baculosa* the figures which are referred to in Savigny and the Revue et Magasin de Zoologie have nothing in common except that they have usually been quoted together by former writers. This is but a specimen of the manner in which this book has been manufactured, and the errors and contradictions which have been pointed out here are as numerous throughout the rest of the book as in the few genera we have so briefly examined. A. A.

IV. METEOROLOGY.

Meteorology.—Director William Haidinger continues to give his particular attention to the investigation of Meteoric subjects, and has in several recent communications to the Imperial Academy of Vienna given information of new meteorites and meteoric phenomena, as well as additional particulars respecting some of those already mentioned in previous papers, of which we give the following abstracts:

(1.) (Meeting of June 20th, 1861.) The fall of the stone of Yatoor, near Nellore, in Hindostan, (the latter place at 14° 23′, N. L., and 80° 4′ E. of Greenwich,) took place at 4½, P. M., on January 23d, 1852, and was witnessed by three persons, who watched their herds in the neighborhood of the Choutoo Canal, east of the village Yatoor, in the Talook of Toumalatalpoor, and west of Yeruguntapollen.

They heard a single clap, similar to the report of a musket, then a somewhat rumbling noise. Looking in the direction of it, they saw, at a distance of about 20 fathoms, dust rising to the height of a man. Going thither they found in the ground, consisting of clay and sand, a hole of two spans wide and two spans deep, (15 to 16 inches,) and therein a *white* stone which was burst, and a fragment of which was carried away at once; the greater portion, however, was dug up on the following morning, by the "moonsiff" of the village. The total weight of the three pieces has been estimated at one mound $=74\frac{2}{3}$ lbs., avdps. The white color of the stone is very remarkable, since meteorites generally show a black crust.* The sky was perfectly clear and the air quiet;

* H. wrote on the margin of the copy of his paper, which he sent us: "*It had a black crust.*"

the report was so unexpected and surprising, that the herds were frightened and ran away. No phenomena of light were observed. Haidinger suggests that the fall took place perfectly vertically. This would give for the season and geographical latitude of Nellore of 14° 23′, N., about three days after the entrance of the sun into the sign of Aquarius, and for 4½ P. M., about in the direction south from Ophiuchus towards the earth; and the Yatoor stone can be considered as having come pretty nearly from this direction.

According to Dr. Andrew Scott, it contains silicic acid, alumina, magnesia, lime, sulphur, iron and nickel.

(2.) At the meeting of July 4th, 1861, he gave some additional information about the Parnallee meteorite, (this Journal, [2], xxxii, 442,) from observations made on a piece of 1 lb. 7½ loth, (= 691 grammes,) which had been sent to the Imperial Cabinet by Prof. Ch. A. Young, of Hudson, Ohio. It forms on one side an uneven fracture plane, of about 4½×3½ inches; about half of the other is covered with a crust, scarcely of $\frac{1}{20}$ of one line in thickness, of a brownish black color, and with but very little lustre. It shows the common roundish depressions, but remarkably enough, some only one half or even one quarter of an inch in diameter, and pretty steep; the direction of the motion of the whole meteorite cannot be determined therefrom. The whole piece is pretty flat.

Numerous pale gray, partly whitish portions, mostly quite roundish, imbedded through the mass, can be observed on a fracture; on polished planes the structure becomes more perceptible, a homogeneous matrix does not really exist, and a lens shows even the minutest portion to be a mixture of heterogeneous particles. Quite a numerous collection of various meteoric rocks would result if we could separate the larger fragments and rounded stones of this meteor, which it would be seen could have obtained their rounded form only in a previous condition. Whitish gray much-rounded fragments, up to ¼ of an inch in size, would pass for fragments of crystalline stones, similar to those of chladnite and piddingtonite of Chassigny and Shalka. The compact black ones, without lustre, of the same size, but remarkably angular, remind us of the peculiar Cold-Bokkeveld meteorites; then there are, in the mixture, metallic, compact or quite finely grained masses of an iron-pyrites of similar size, more angular in shape, and quite indifferent to the magnetic needle, hardly to be considered pyrrhotine, although their specific gravity, at 18° R., was = 4·520. Fine particles of metallic iron are also present, but in very small quantity, so that the specific gravity of the piece at 18° R. was =3·175; yet the stone was porous, and continually giving out a stream of air bubbles, so that it may perhaps be above 3·2.

The most remarkable constituents, however, are certain much rounded yellowish or brownish particles, often yellow within and dark brown without, similar to those from l'Aigle, Chantonnay, Mentz, Segowlee, which on polished planes appear like being inclosed with brilliant metallic rings. But this inclosure is not produced by metallic iron, but by a substance like iron-pyrites. It shows but very isolated traces of incrustations by metallic iron, as in the meteorite of Assam, (this Journal, [2], xxx, 143,) and very characteristically in those of Serez and Renazzo. The incrustation of pyrites, however, must have taken place exactly in

the same manner as that by metallic iron; the particles of matter—whatever may have been the agency required to dissolve the metallic iron, or a sulphid of it, and precipitate the same—were moveable and collected by moisture on the surface of the rounded fragments of rocks in the meteoric tufa, originating in the beginning from dust. In the larger masses of sulphid of iron are also minute particles of metallic iron.

On the whole, the Parnallee stone resembles the beautifully marbled stone of Assam and that of Chantonnay, but it is distinguished by its greater porosity and a less compact structure.

Dr. Andrew S. Scott mentions the following constituents as the result of a qualitative analysis: Silicic acid, alumina, ferric oxyd, magnesia, lime, iron, nickel, sulphur, and traces of cobalt and chrome.

(3.) At the meeting of October 17th, 1861, he made a communication regarding the meteorites of Montpreis, which fell July 31st, 1859. A letter of Mr. Mischitz, of Montpreis, to Prof. Suess, of Vienna, dated June 27th, contains the following data:

"Joseph Kozel, Francis Romich and myself observed the ball on July 31st, 1859, about 9½ P. M., when suddenly the sky towards north, in the direction of Paher, became illuminated, and the meteor moved from the north over the castle of Montpreis with a hissing noise down through the air, with the velocity of a shooting star, but larger in size and of more brilliancy, and fell right in front of the church of Montpreis and the wall of the churchyard, partly upon white sandstone, partly upon the solid gravelly soil. This fall produced a small excavation of scarcely the depth of half a nut-shell, burned the sandstone and soil as large as a silver dollar. All the fragments were visible in a glowing state, during 5 or 8 seconds, and when F. Romich picked one up he burned his fingers considerably, so that we were afraid to pick them up. A quarter of an hour later I picked up the pieces yet warm and three in number; the rest was like sand or street dust in the black-grey burned hole, and scattered over the similarly burned stone. All the pieces have, unfortunately, been lost. The fire of the mass was rather more yellowish than red. The fall, when touching the ground, was accompanied by a little clap, similar to that produced when rockets filled with star-fire, and yet burning, touch the surface of water. The pieces picked up looked like slags, with a thin black crust." Although nothing has been preserved of this fall, it is fully authenticated, and shows, besides, some important peculiarities.

It is particularly remarkable that the three pieces showed bright red heat a few seconds after their fall. They were certainly stone and not iron, or they would not have been broken into so many fragments, like sand and street dust. We have no records of high temperatures of stones; they are generally not warmer than if they had been lying in the sun, while on the other hand we have an example of the exceedingly cold and very large stone of Dhurmsala. The stone of Montpreis weighed scarcely more than 140 grammes. We might imagine that a small stone, especially if pretty well intermixed with metallic iron, could be thoroughly heated from the surface and become red hot, whilst the high temperature produced by the resistance of the air would not be sufficient to overcome the cosmical cold of the interior of a large stone, during the short time of its cosmical path through our atmosphere.

The stone appears not to have had much of a fireball, but simply to have been red hot, the only, and at that very insignificant, noise was produced by its striking the stone and soil, the surface of which it penetrated but very little, showing that it could not have come down with cosmical velocity.

The fall took place obliquely, in the direction from north to south, but much deviating from a vertical line.

The geographical situation of Montpreis is about 46° 7′ N. latitude, 15° 27′ E. of Greenwich. Adding the northern zenith distance of nearly 7° to the latitude, we obtain the altitude of 58°, from which the meteor descended. An astronomical map, set for July 31st, $9^h\ 30^m$, gives the position of the meteor at 270°, very nearly in the foot of Hercules, next to the head of the Dragon and Vega. The position of this region towards the earth is almost directly opposite to the translatoric motion of our solar system in space, which, according to Mädler, is 7 miles (German) per second. We might presume, therefore, that, as far as its position is concerned, the descending meteor remained stationary, or its approach was merely effected by the translatoric motion of our solar system. As to the motion of the earth in its position in space, between Aries and Taurus, we may assume the nearly conformable motion of 4·1 (German) miles per second. Thus the meteor would have descended on the ecliptic, probably from the neighborhood of the Balance, perhaps a real stranger to our solar system.

A communication of Dr. Kreil to Prof. Suess mentions several meteors, which were observed nearly on the same date:

At Kremsmünster, on the 29th, in S.S.E., a large fireball, with a bright luminous tail, which fell almost vertically towards the horizon. It lasted 3 to 4 seconds.

At Laibach, on the 29th, at $8^h\ 48^m$, a meteor in S.W. direction.

At Edelbach, near Montpreis, (in Lower Styria,) towards S.W., a fireball, followed by three shooting stars; much hissing, rumbling fall, but nothing was found.

At Neustadtl, (Krain,) a meteor, like that at Laibach.

(4.) At the meetings of October 17th and November 7th, 1861, he gave some additional information about the metallic iron masses from Cranbourne (near Melbourne, Victoria,) (this Journal, [2], xxxii, 441–443). The smaller mass, of about 3,000 lbs., is exhibited in Melbourne and intended to be sent to the World's Fair, which is to take place in London during this year.

The photographic view given represents it in its present position at Melbourne, which is the *reverse* of the original one. The following approximate measurements were sent by Dr. Neumayer, and refer to the block in its *original* position:

Viewed from	N.E.	to	S.W.	=3 ft. 1 in.,	S.E.	to	N.W. =1 ft.
"	"	base,	"	=2 " 8 "	Op.	"	= — 11 in.
"	"	N. Oc.	"	=1 " 1 "	St.	"	=1 " 9 "

The inner structure of the smaller piece could not well be determined from the few chips cut off with a chisel. Here and there was a wire-like structure visible, and richly disseminated through the whole mass, silver-white laminæ of schreibersite, showing but little lustre. No real crust

was observed, but a pretty large coating of hydrated ferric oxyd, a proof of a very long period since its fall. In the well known roundish depressions was an hygroscopic substance, considered as containing ferrous chlorid. The sp. gr. found by Dr. Neumayer from 7·51 to 7·60; that of the coating, = 3·66.

Some of the chips, sent to Vienna, showed plainly, when sufficiently etched, the projecting edges of schreibersite; well polished plates, when exposed to heat, beautifully the pale yellow lines of schreibersite, in the darker violet and blue ground. An analysis, made by Karl von Hauer, gave:—very little insoluble residue, 95·43 p. c. of iron, and 3·40 p. c. of nickel, with a little cobalt.

The approximate measurements of the large, yet unmoved and apparently immovable mass make it in the direction of

N S	=	5 feet,	— inches.
db	=	3 "	1 "
gc	=	3 "	11 "

A part of the mass has been separated and partly worked up.

In a figure given in H.'s communication the mass is viewed from the north; the surrounding ground has partly been dug up; its probable height is estimated by Dr. Neumayer as not over 4 feet, the neutral plane towards magnetism being 1 ft. 10 in. below its upper limits, and 2 ft. 1 in. distant from its most southern point. Although the upper part is a strong north pole and the lower a south pole, numerous subordinate poles are distributed over the whole surface.

The positions of the two masses are given more accurately and completely than before. Their direction, in an astronomical line, is from S. 34° W. to N. 34° E.; their distance from each other 3·6 miles, (60 to 1° of the equator,) the smaller northerly of the larger. The geographical position of the smaller mass is 38° 8′ S. lat., and 145° 22′ E. of Greenwich; that of the larger, 38° 11′ S. lat., and 145° 20′ E. of Greenwich.

(5.) At the same meeting (Nov. 7th, 1861,) he mentions a magnificent meteor, observed by many persons in Southern Australia, on March 4th, 1861, at bright daylight, ($9^h\ 38^m\ 5^s$, Melbourne mean time,) of which Dr. Neumayer made a report to a Melbourne paper, computed from 26 observations. When first seen it was 50 miles above the ocean, and at a point of the ocean 30 miles from Cape Otway; it passed through the zenith; its diameter has been calculated at about 1,900 feet. From Neumayer's continued investigations (during the last 3 years) of shooting stars and meteors, it follows that this meteor came from a point of radiation in Perseus; whilst a meteor of extraordinary size, observed at Melbourne in August, 1858, came from the latter point and moved towards the former, so that both meteors had one and the same plane of motion; a fact which, if investigations were pursued, might throw some light upon this subject.

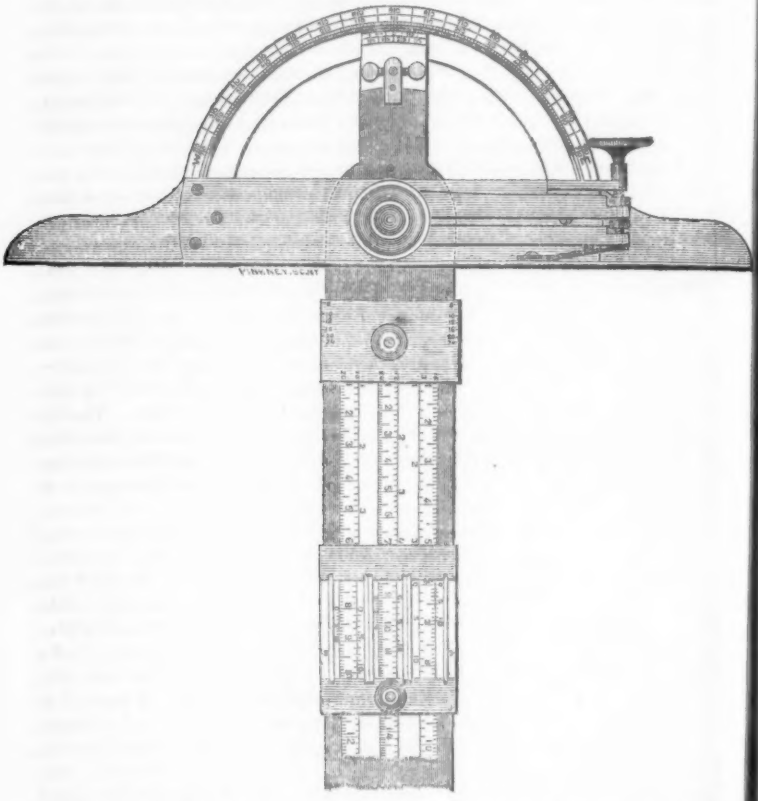
There are, according to Neumayer, other points of radiation for the southern hemisphere, and the periodical appearance of these celestial bodies does not coincide with that for the northern; there is no August period, but one in July and one in December. No observations could be made during the last three years in November, on account of the unfavorable state of the weather. F. A. Gth.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *The California Geological and Natural History Survey.*—Good progress has been made in this important work, during the year and a half in which it has been in progress. We have received copies of a "Letter of the State Geologist relative to the progress of the State Geological Survey," addressed by Prof. Whitney, to the Governor of California, and dated December, 1861. This gives the organization of the Survey and and outline of the ground gone over in the first year's explorations, showing great industry, the area already explored being equal to at least one half the area of the State of New York. Forty-seven maps have been commenced on a scale of half an inch to a mile. The map of the region about San Francisco Bay comprising but a little corner of California (almost exactly the area however of the State of Connecticut) is nearly completed. The Topography of the State being so imperfectly known, a large amount of labor and expense falls on the Geological Survey in providing the Geographical elements essential to even a tolerably exact location of geological facts. Barometrical observations have been constantly kept up, and the data obtained for the determination of the elevation of about one hundred and fifty important points. Among others the Peak of Shasta about which such contradictory reports exist will be this summer the object of special barometrical examinations. Large collections of facts and specimens have been made in General Geology, Palæontology, Economical Geology, Botany, Agricultural Geology and Zoology. The preliminary Reports of the first and second year's work will be published in one volume, which may be expected by March, 1863. The law requires the Reports of the State Geologist to be sold for the benefit of the School Fund, which requirement prevents our using important geological information derived from the labors of the Survey, in advance of its publication. The appropriation made for the continuance of the Survey for the current year has been cut down to $15,000, one half the sum asked for by the Geologist-in-Chief (viz: $30,000), owing to the disturbed condition of the public finances and the sad disaster by the flood of last winter, which made wreck of a large part of the taxable property of the State. It is satisfactory to know that the floods have not been however, an unmixed evil, but that by their agency there is every prospect of a largely increased gold product this year. California is a vast region to explore, its area being twenty times that of Massachusetts, and equal to the united area of Great Britain, Ireland, Belgium, Hanover, and Bavaria. The work is laborious not more from the extent of surface, than from its heat, dust, chaparral and want of roads. It is proper to say that the Geological conclusions already reached, fixing the true age of the auriferous and other metallic deposits, and of the Coal, are of the greatest importance. The work for 1862 has been reduced in proportion to the diminished appropriation—the finances of the State being so deranged as to prevent even the prompt payment of the money appropriated. Prof. Whitney has wisely concentrated his remaining force upon the field work, determined to make the reconnaissance as complete as possible before the publication of the first volume of the report.

2. *Lyman's Trigonometer.*—Mr. Josiah Lyman of Lenox, Mass., has made a very valuable addition to our instruments for exact geometrical drawing. It consists in a happy combination of the protractor, straight

edge and scale of equal parts. It is to be used in connection with a draughting board which has its sides adjustable. The instrument is best understood from the cut. The long side of the semicircular protractor being placed against the edge of the draughting board, the steel ruler may be turned to make any required angle with the edge of the board. The angles are read by a vernier to minutes. A tangent screw and clamp afford facilities for small movements.



Upon the ruler slides a scale plate for measuring distances or for laying them down. There are six scales, representing divisions of the inch into 8, 10, 12, 16, 20 and 24 parts. Each has a vernier to tenths, and on most of them smaller parts may be estimated. The edges of the two parts of the sliding rule come down over the edge of the ruler to the surface of the paper, and fine marks on these edges make it easy to lay down accurately on the paper the distances indicated on the scales and verniers.

The instrument thus affords the means of plotting angles and distances with great accuracy and dispatch. The aim has been to make it possible to lay down angles to minutes, and distances to thousandths of an inch.

One great advantage of the instrument is, that it facilitates the computation of areas in land surveying. Anything which abridges the labor, of a process so frequently repeated, is of value. When the corners of a field have been plotted, the differences of latitude and the meridian distances can be measured, in a very short time, with an accuracy far greater than that ordinarily used in the field work of a survey.

No pains have been spared in the mechanical construction to make the instrument accurate. The methods of using it are fully detailed in an accompanying manual. This manual forms of itself, in fact, almost a complete treatise on land surveying.

3. *Donation of types of American Reptiles by the Smithsonian Institution to the Civico Museo of Milan.*—In the May number of this Journal we published a note from Prof. Henry, in reply to a statement, by our Paris correspondent, that the Smithsonian Institution, (excepting the British Museum,) was almost the only great establishment that had not contributed materials towards the work on serpents of Prof. Jan of Milan. In a recent article by Prof. Jan on the *Typhlopidæ*, in the Archivio per la Zoologia, etc., of Genoa, vol. i. p. 196, we find the following remarks:

"We have received from the Smithsonian Institution original specimens of nearly all the species (of serpents) described by Baird and Girard, and other American authors, and from the Museum of Philadelphia various types of Hallowell and Cope. Nearly all the specimens sent by the Museum of Washington are intended permanently to enrich our collection, thanks to the generosity of Dr. Henry, general Secretary of the Smithsonian Institution, and worthy interpreter of an establishment founded with the single object of promulgating and diffusing scientific knowledge, and of according to all those occupied in such pursuits, an efficient assistance and the most ample protection; an establishment, of its kind, not only rare but unique in the world."

OBITUARY.

Edward C. Herrick, died in New Haven his native place, June 11, 1862, aged 51 years. Mr. Herrick's name has been identified with the history of American science for a generation, and it was a household word to the readers of this Journal. Scarce a volume of which, since 1836, has been without some contributions from his pen. Mr. Herrick possessed an encyclopedic knowledge; his mind grasped with equal tenacity and accuracy a great variety of subjects rarely compassed by one individual. His first published memoir was a description of the Crustacean *Argulus catostomi* in connection with Prof. Dana. It is worthy of notice, in passing, that the first contributions to science published by three of those who have since been known as among our most constant and valued contributors, viz: Profs. Gray and Dana, and Mr. Herrick, appeared in the same number of our first series, viz: vol. xxxi, No. 2. Mr. Herrick's favorite study, in Zoology, was among insects. His researches into the history, habits and parasites of the Hessian Fly, (*Cecidomyia destructor* Say) are well known to entomologists. His principal published papers on this insect, appeared in 1841,[1] but his researches were continued, at intervals, through life. His last contribution to this Journal was on the seventeen-year locust, and a critical notice of the new edition of Harris's Insects injurious to vegetation.[2] But Mr. Herrick has been much

(1) This Journal, xli, 153. (2) [2], xxxiii, 433–434.

better known to our readers by his very numerous contributions to meterology and astronomy. He was one of the first to point out the existence of the August period of shooting stars,[3] his observations having been published before reports of European discoveries had reached this country. Our knowledge of a shower in December and of one in April is mostly due to him. His catalogue of showers in past times,[4] which was the fruit of immense labor, was so complete that few undoubted instances have been added by those who have since labored in the same field.

For many years he was a constant observer of the Aurora Borealis, and by his zeal influenced many others to make similar observations. He first called attention to the frequent occurrence of this meteor in summer, at a time when the opinion was general that it was chiefly if not entirely confined to the winter months,[5] a subject vividly brought to his notice by a remarkable Aurora on the 1st of July, 1837[6].

Science, with Mr. Herrick, was only the recreation of a laborious life of business. Trained as a bookseller, and for a time conducting that business on his own account, he was in 1843 chosen Librarian of Yale College, and, in 1852, Treasurer of the same Institution, holding the latter office until his death. Mr. Herrick was eminent for his knowledge of books and precise memory of all that related to them. We copy the following from an appreciative notice of Mr. Herrick which appeared in the "Daily Journal," for June 12th, 1862:

"In that varied and miscellaneous knowledge which was congenial to a person of his comprehensive curiosity, his active habits, and his iron diligence, he had scarcely his equal in the University, and the extensive correspondence which he maintained for years with persons of varied pursuits, residing in every part of the country, and in Europe, is both an evidence that his knowledge was extensive and highly prized, and a monument to his industry and his disinterestedness. As a man of business, he was distinguished for quickness, sagacity, and the rarest integrity. The whole community knew him as one of the few in whom all might confide, and whom none could possibly suspect. His reputation in these respects was such as but few mortals attain or deserve.

As a friend he was affectionate and true—spending his services and his care for all that needed them, and often doing this with a lavish hand. Few men have cherished so sacredly, and have exemplified so perfectly, the saying of the Lord Jesus: "It is more blessed to give than to receive." His habits of life, interesting and peculiar as they were,—his genial severities, and his good-natured asceticisms,—his charming simplicity,—his delight in nature,—his generous readiness to serve his friends,—his kindness to the poor,—his genuine, yet never malignant, hatred of oppression, injustice and trickery,—his pining love for his mother, with many nameless traits, peculiar and unique, were wrought together into a character of rare interest to the friends who delighted in his society, and never ceased to wonder at the singular, yet not inharmonius, blending of traits appropriate to Socrates and the Apostle John."

It was in harmony with his deep modesty of character that he ordered that his funeral should be private, and that no eulogy upon his life should be pronounced.

(3) This Journal, [1], xxxiii, 176, 354, 401. (4) [1], xxxv, 366, xl, 349, 365, xxxix, 334, xliii, 201, 398. (5) [1], xxxiii, 299. (6) xxxiii, 143.